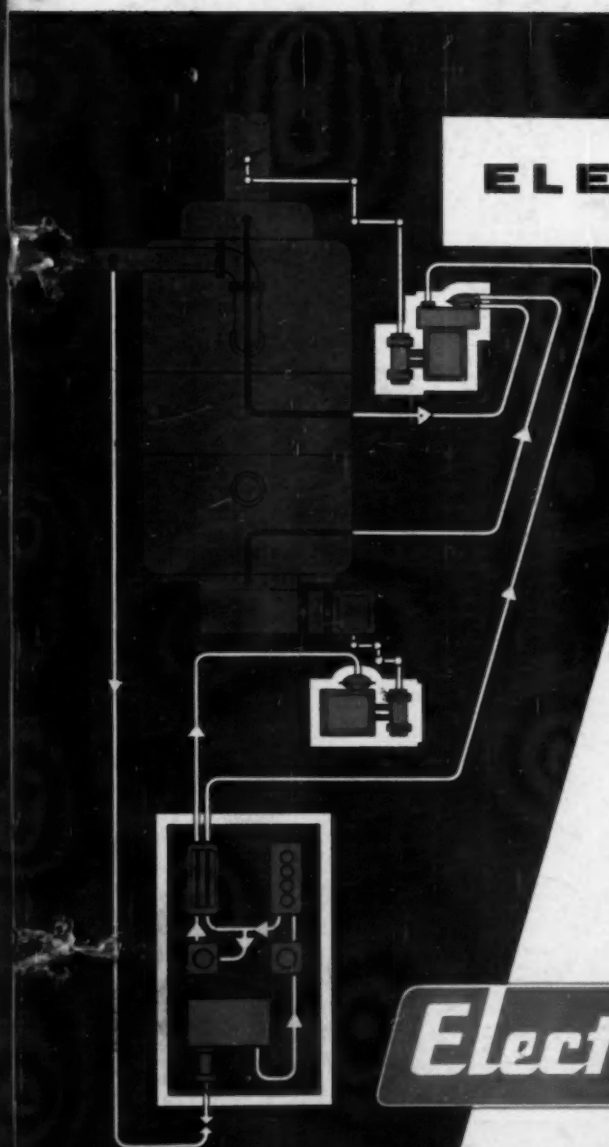
ENGINEERING AND

BOILER HOUSE REVIEW

VOL. 73 NO. 3 • THE PIONEER STEAM JOURNAL • MARCH, 1958



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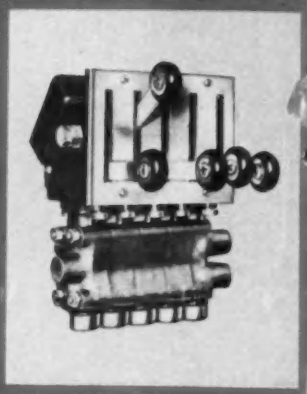

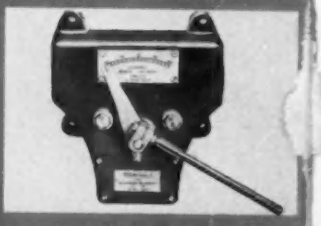

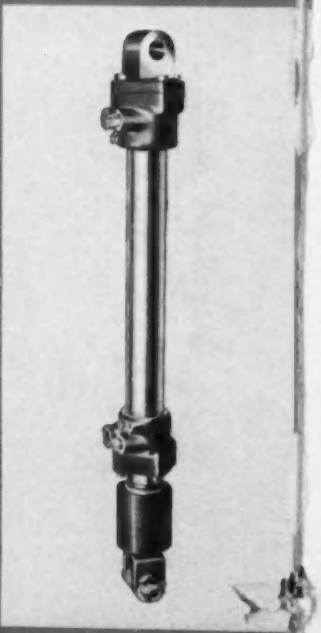

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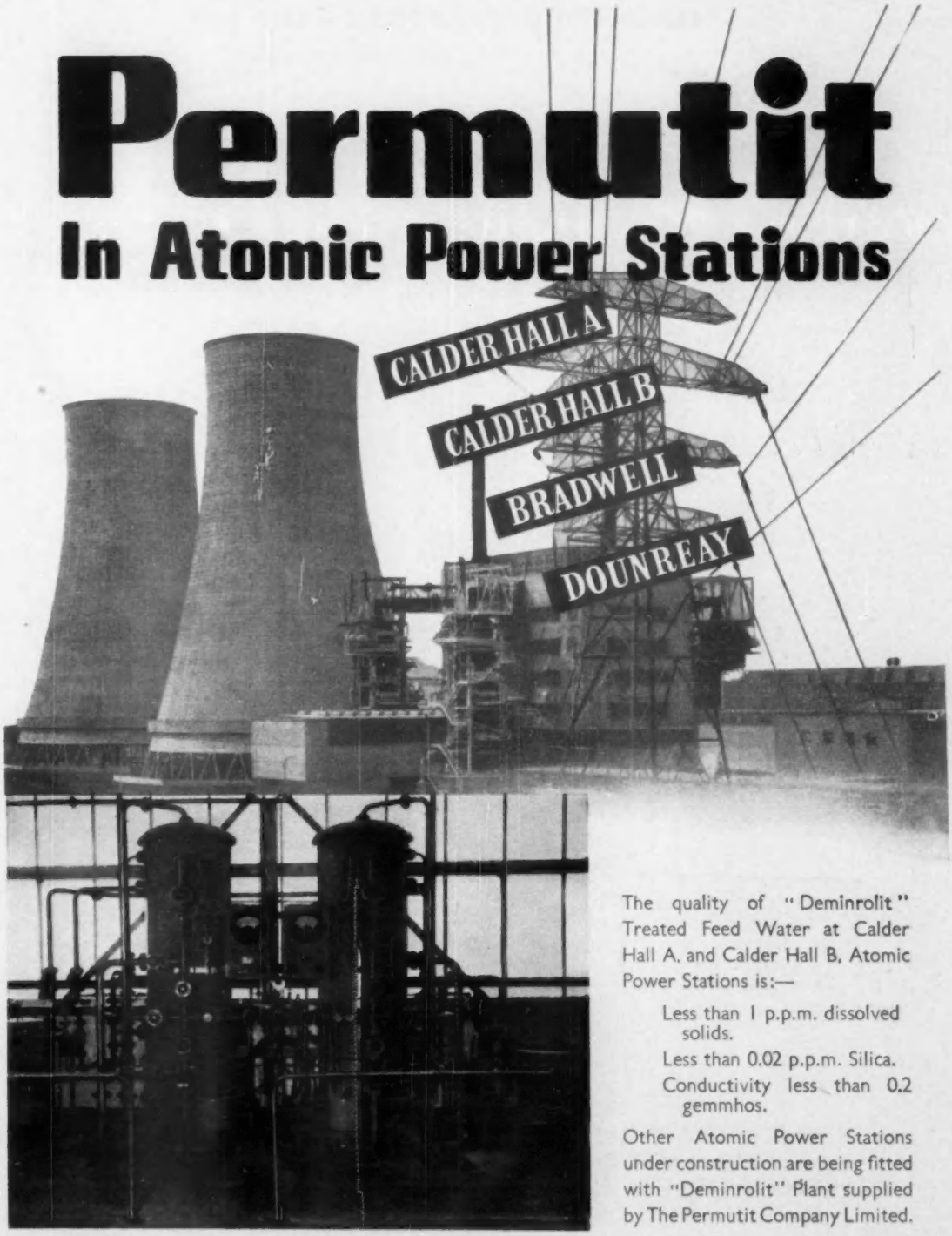

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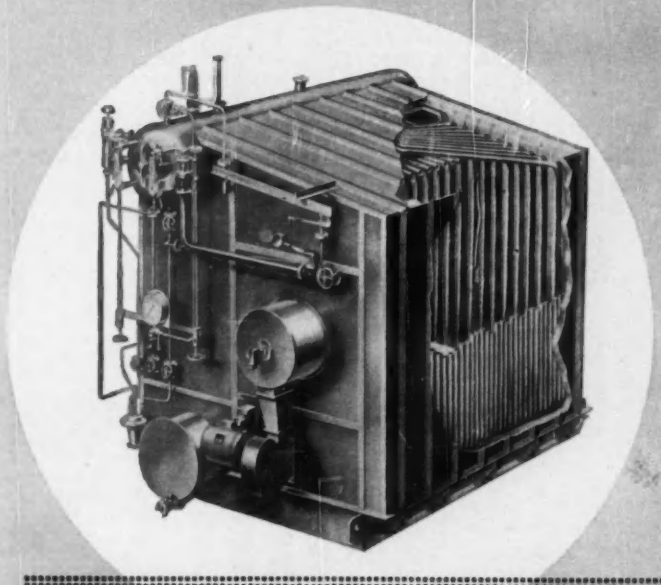

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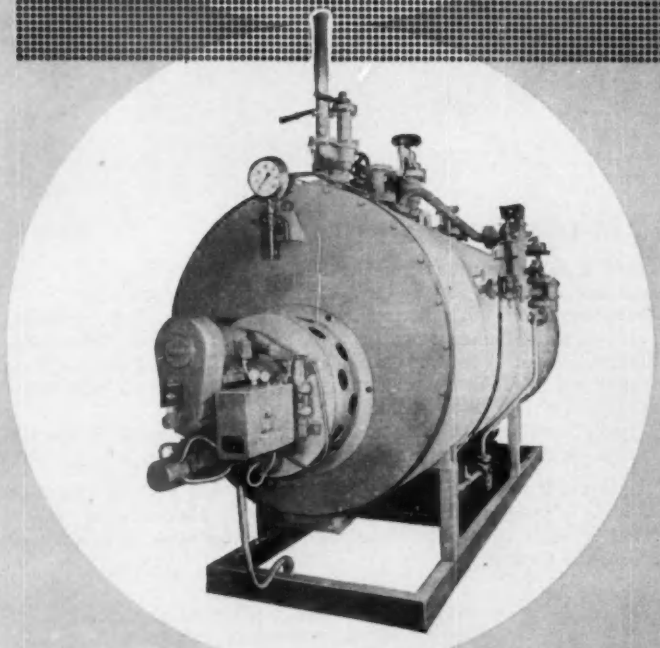

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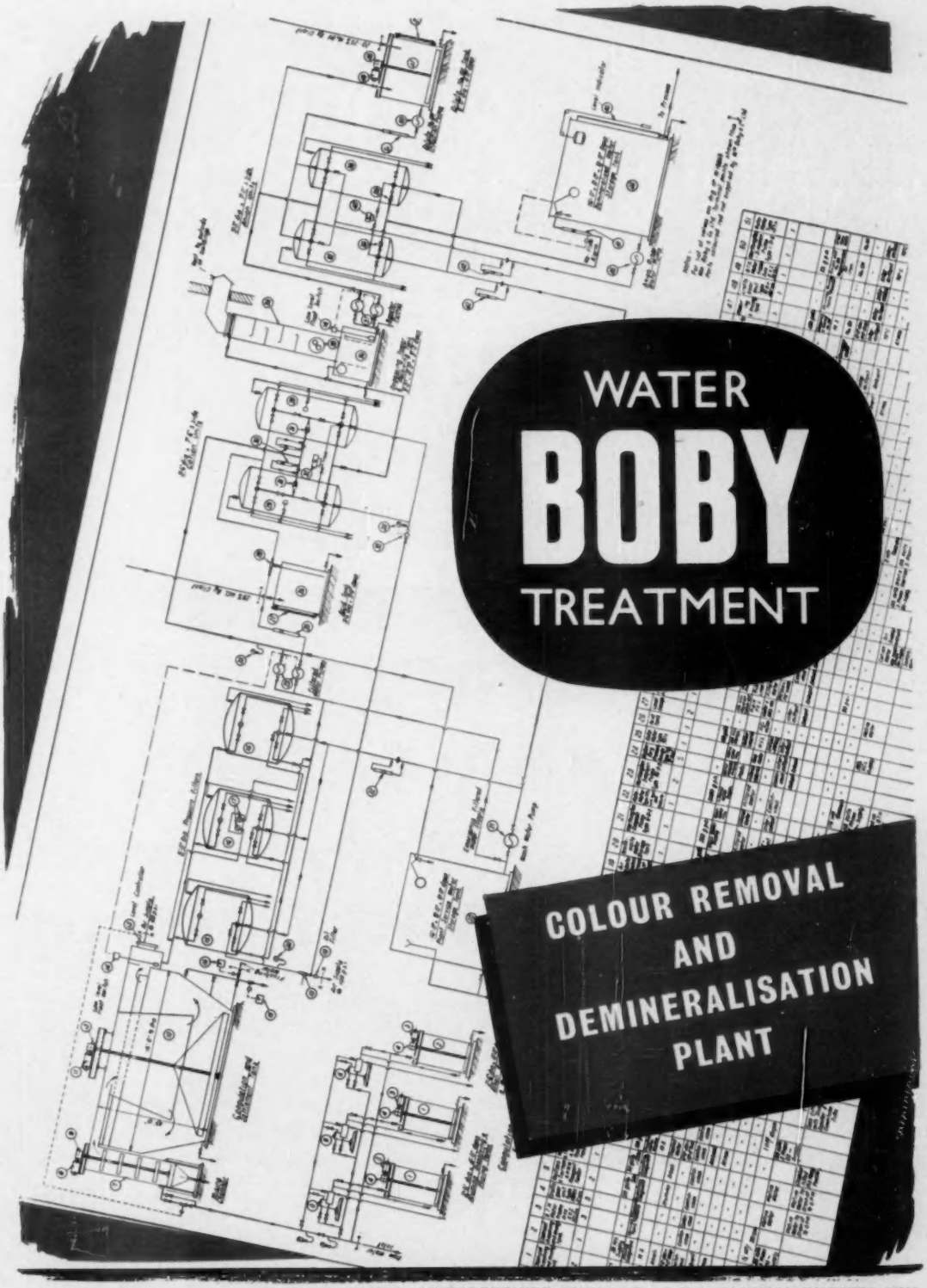

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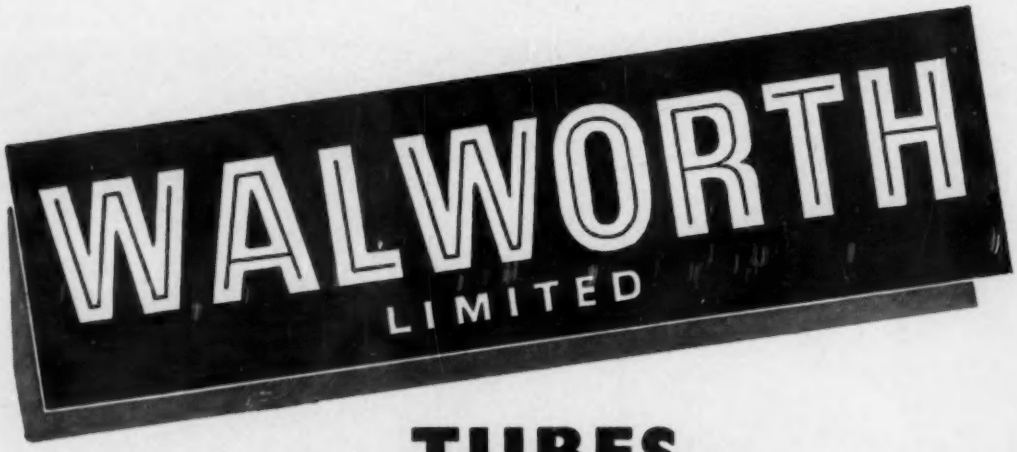

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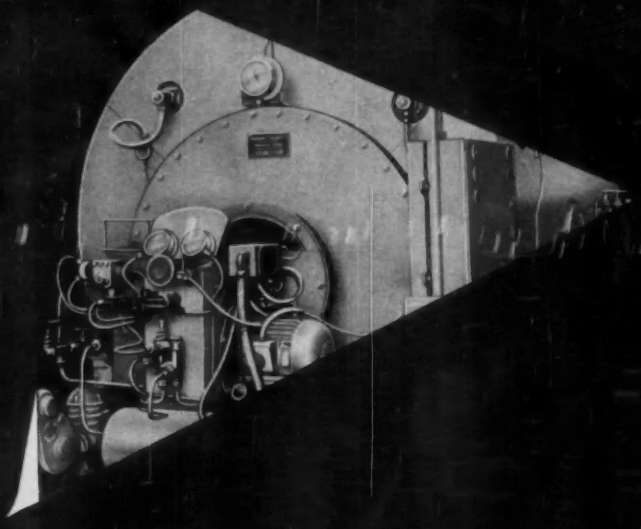

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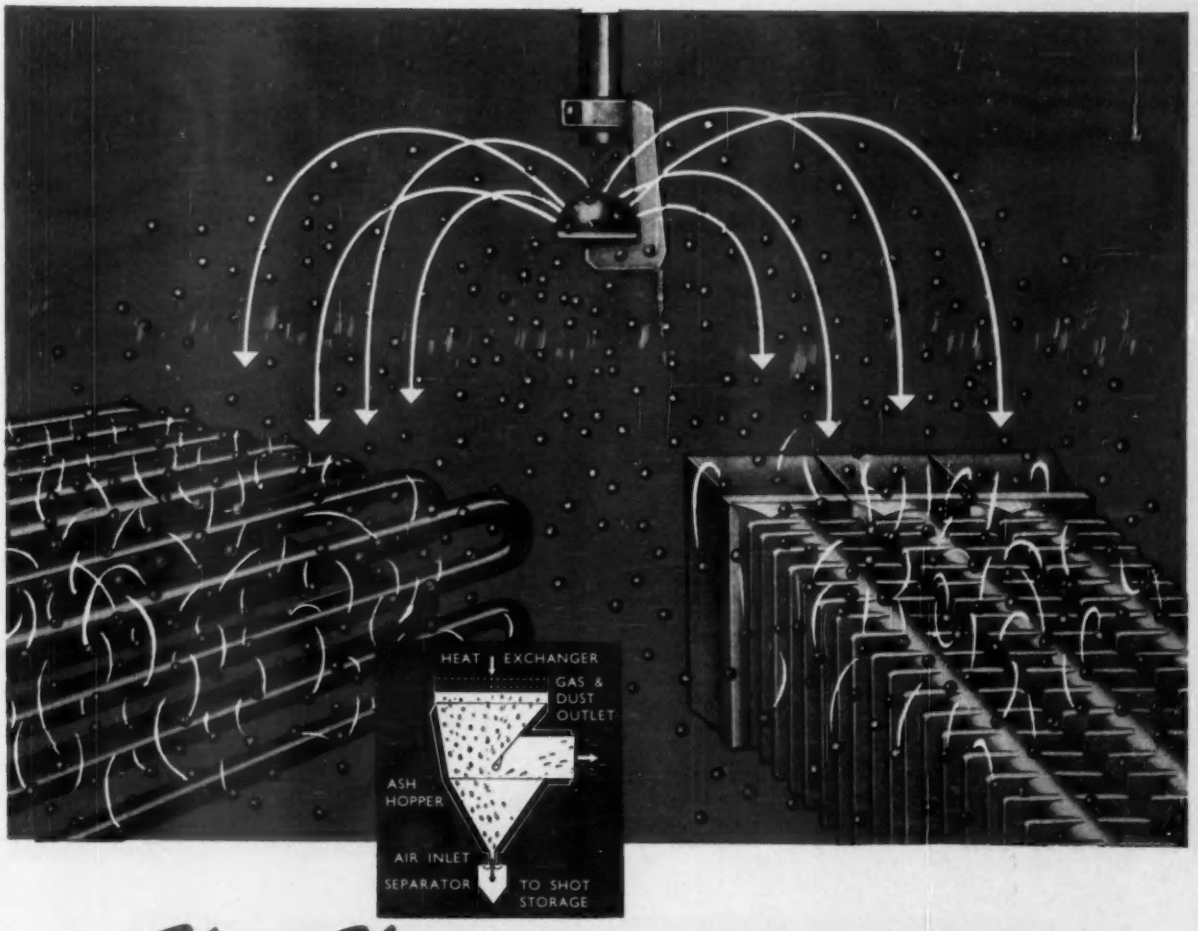

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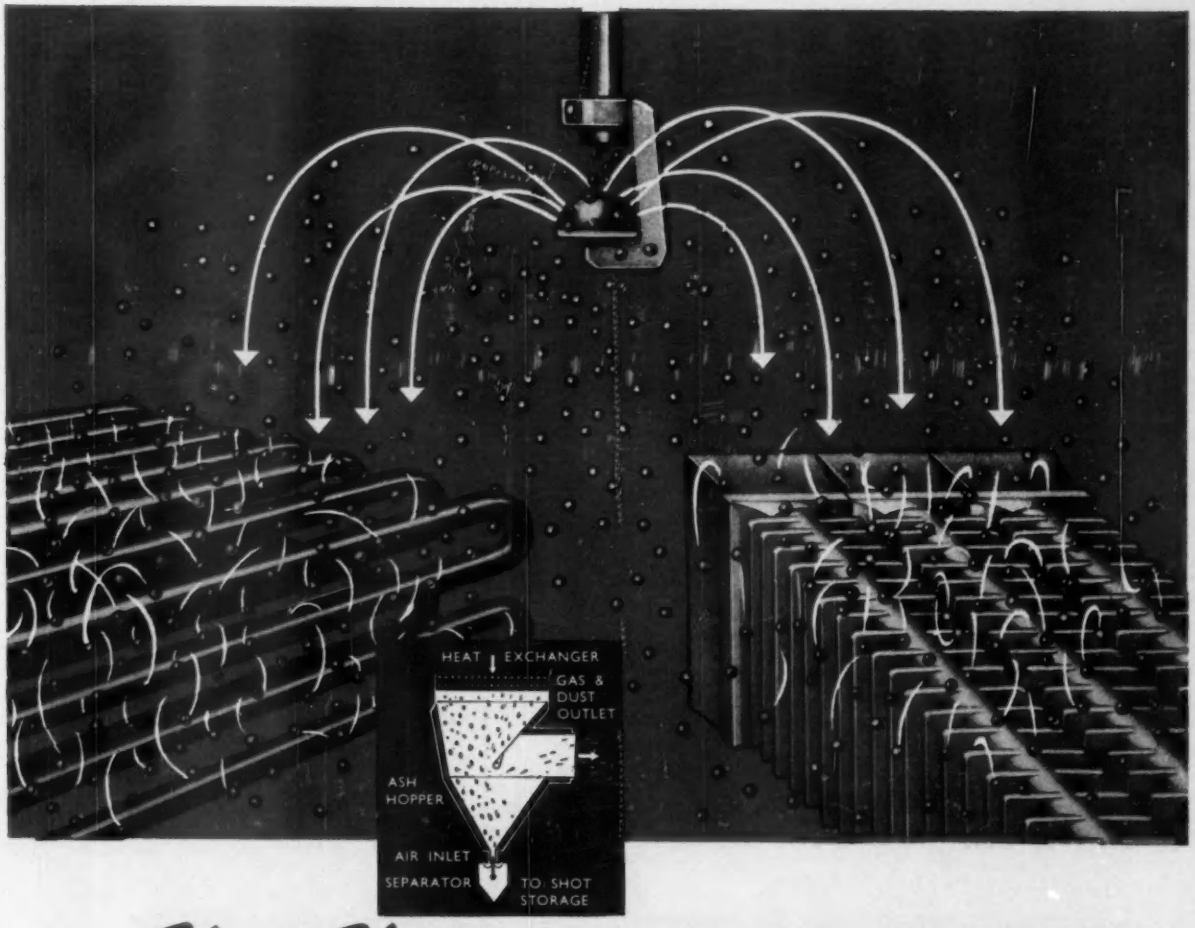

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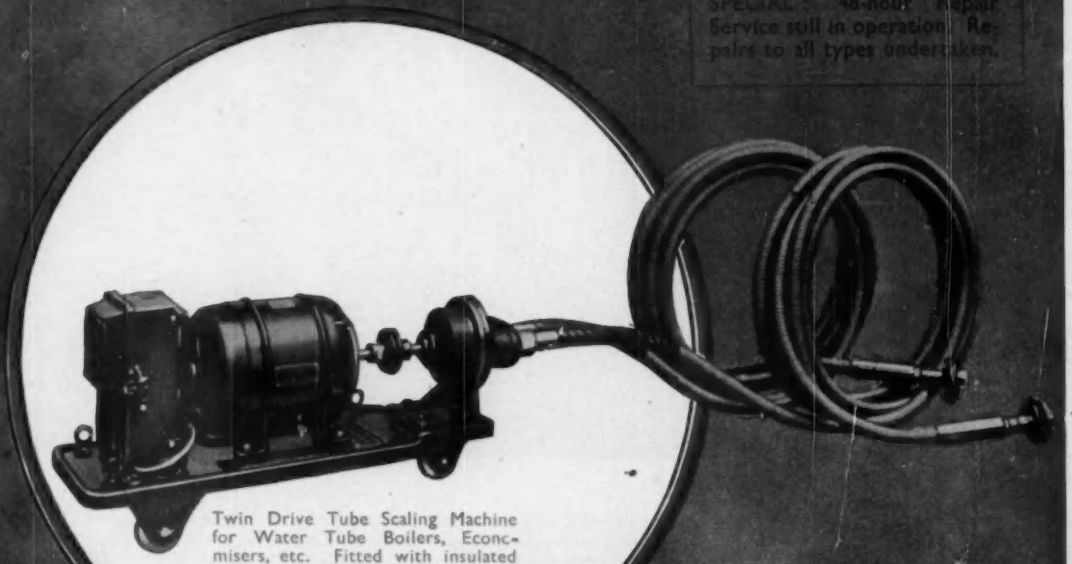

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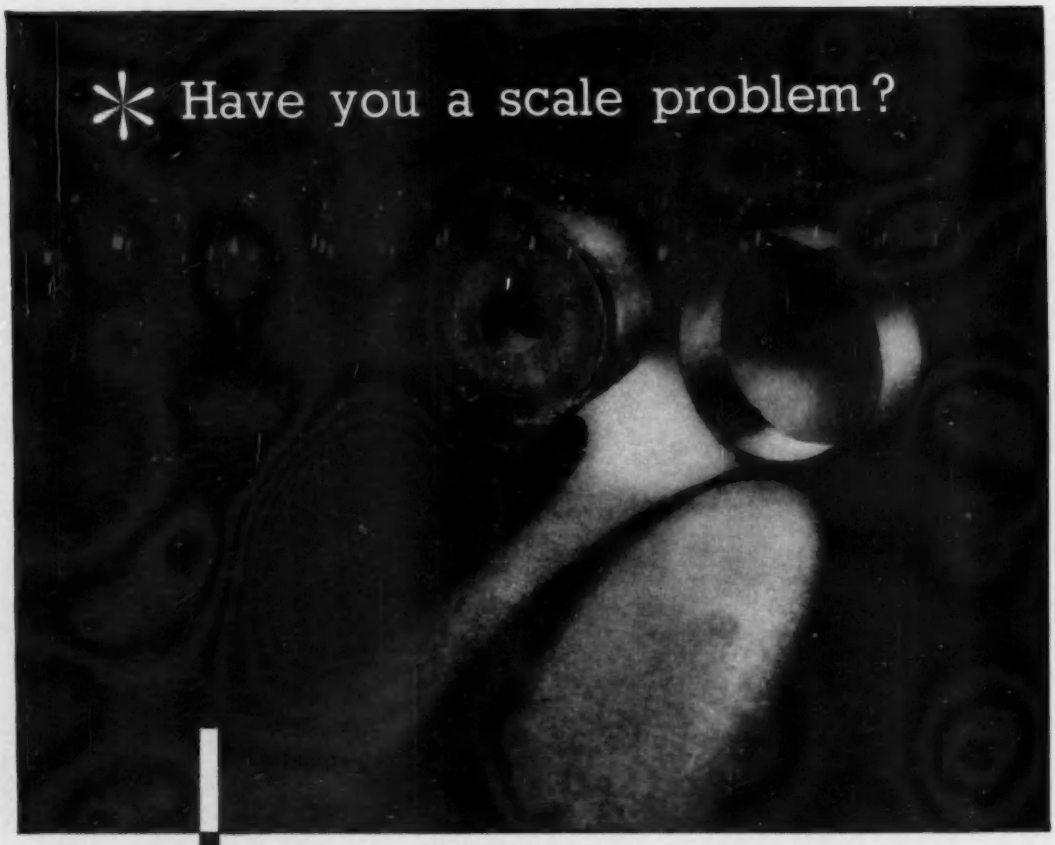

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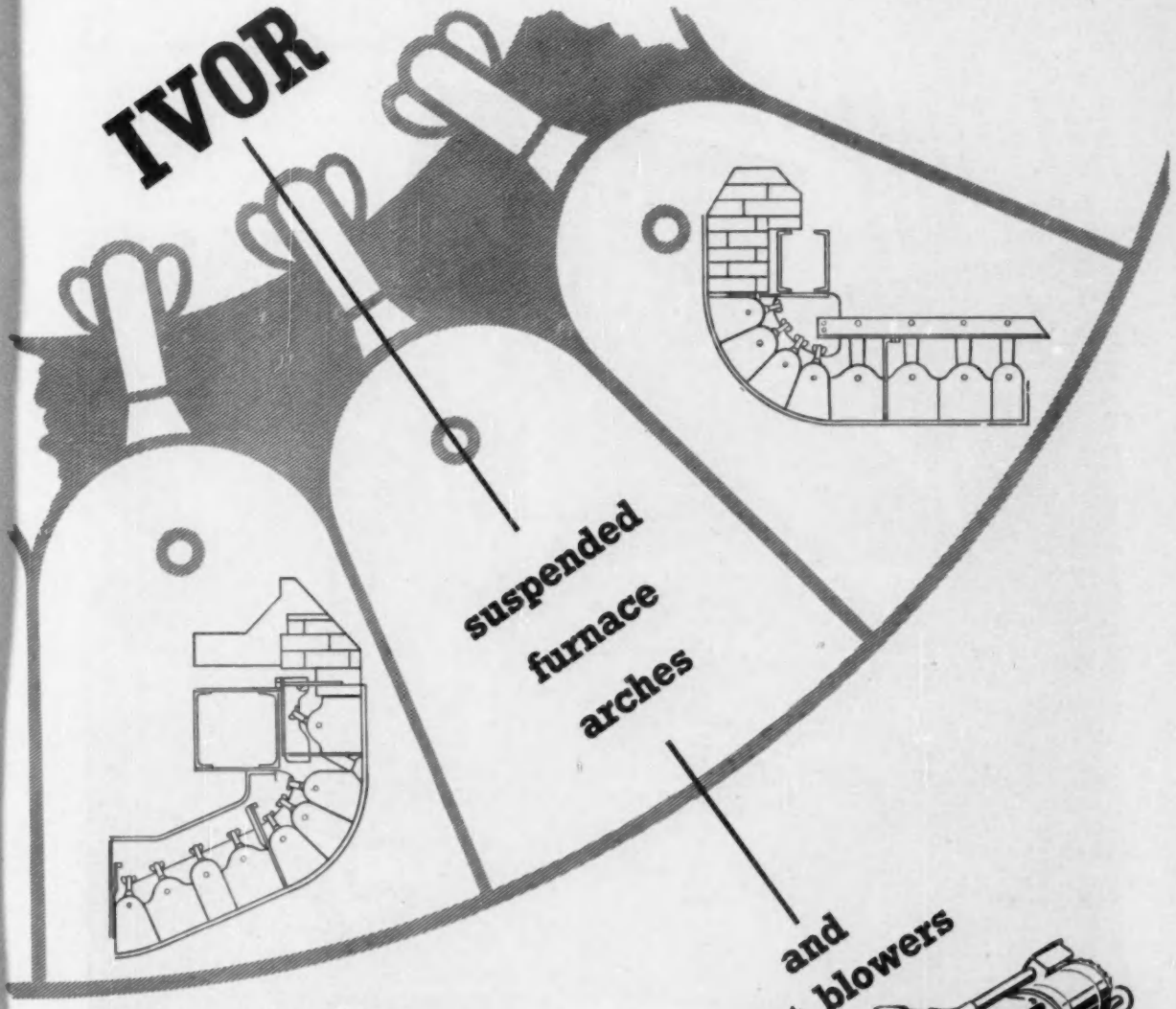

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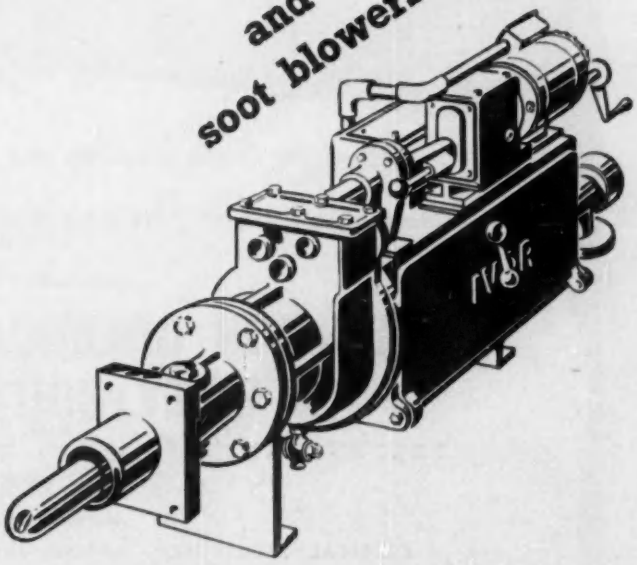

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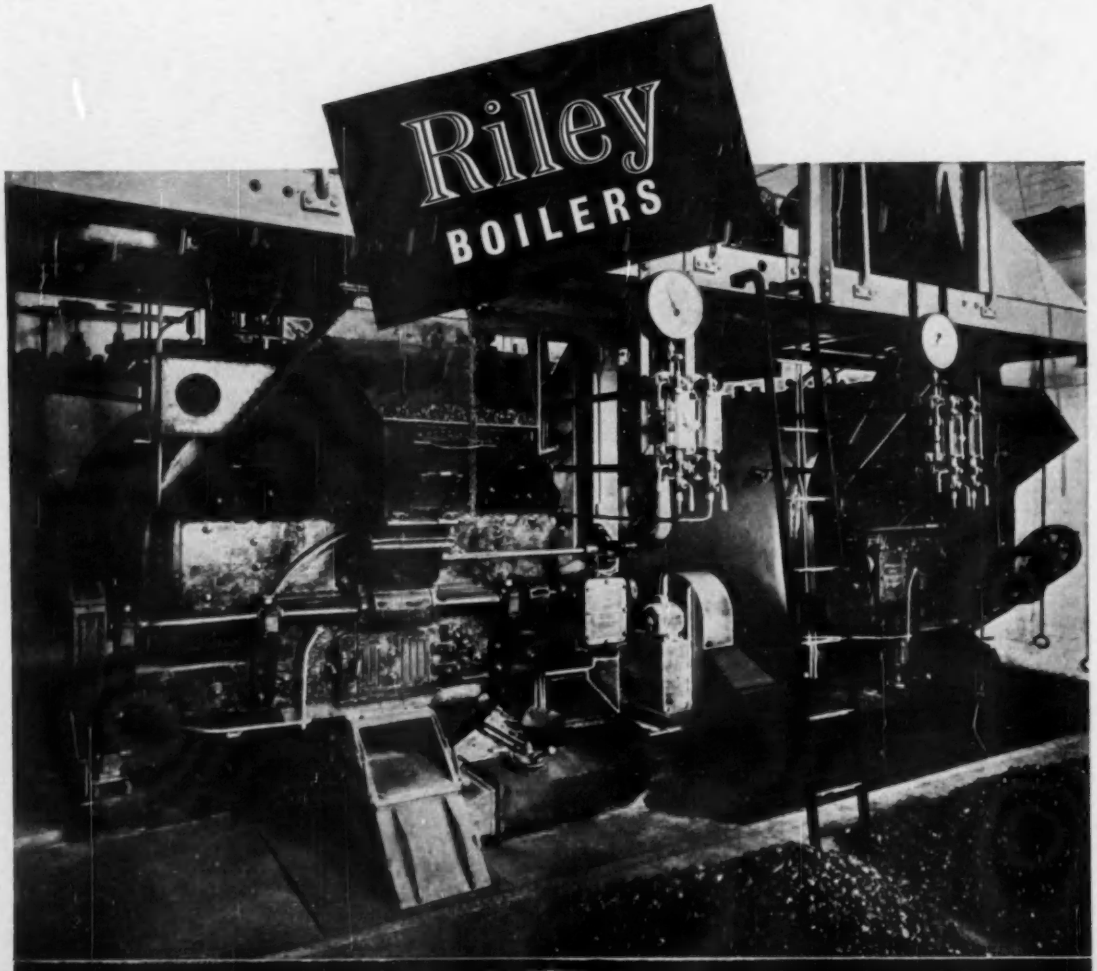

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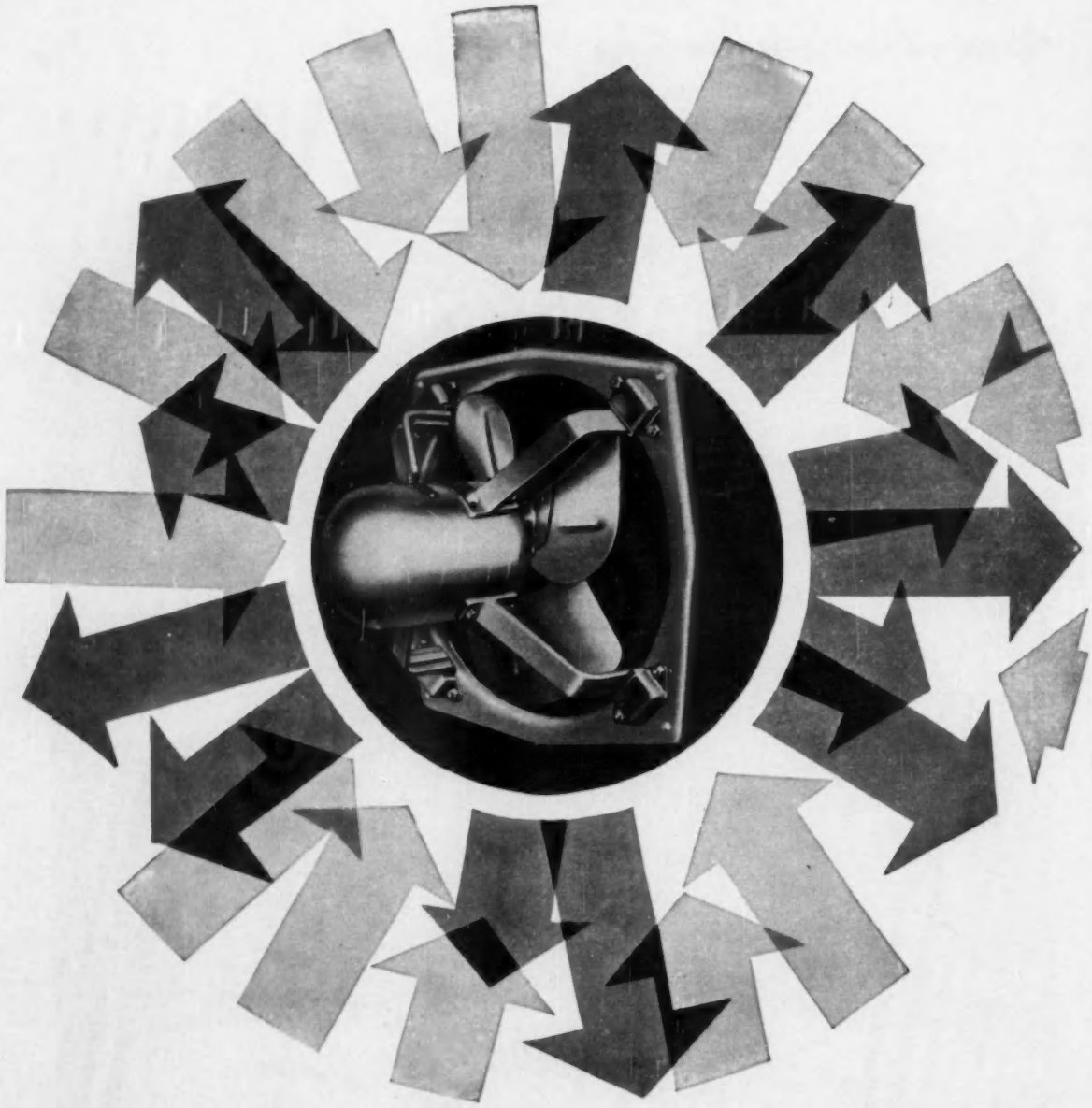

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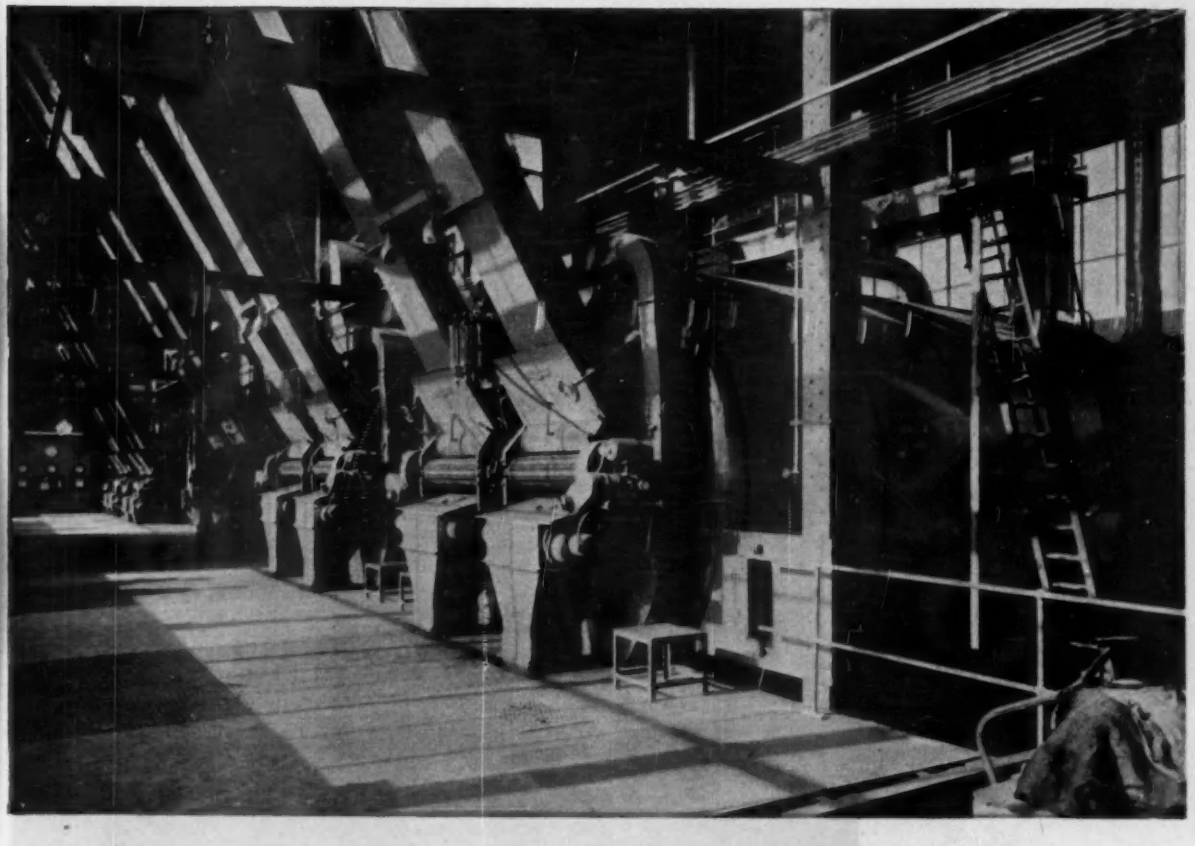

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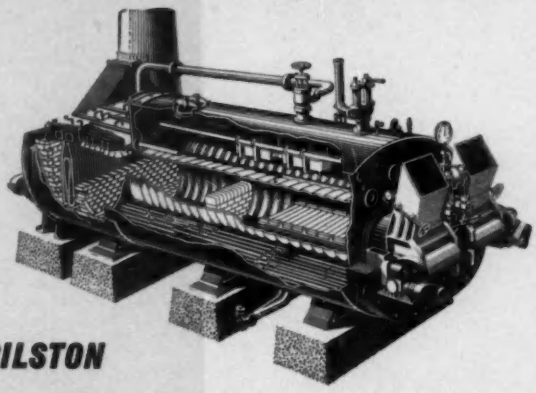

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The new boiler plant at Joseph Sankey and Sons Ltd., Bilston, has five John Thompson Super Economic boilers, stoker fired. Three of the boilers each have an evaporation of 15,000 lb/hour and the remaining two 10,000 lb/hour, working pressure 120 lb/sq in The larger boilers are equipped with superheaters. Mechanically operated ash extractors are fitted to the Thompson-Triumph stoker, the ash then passing to the John Thompson submerged-belt ash conveyor. Equipment manufactured and erected by members of the John Thompson Group of Companies included boilers, stokers, chimneys, feed tanks, coal and ash handling plant, pipework, walkways, ladders and windows, instruments and panels, ducting, superheaters and feed water treatment plant. Consultants for this installation were Messrs. Powell Duffryn Technical Services Ltd.

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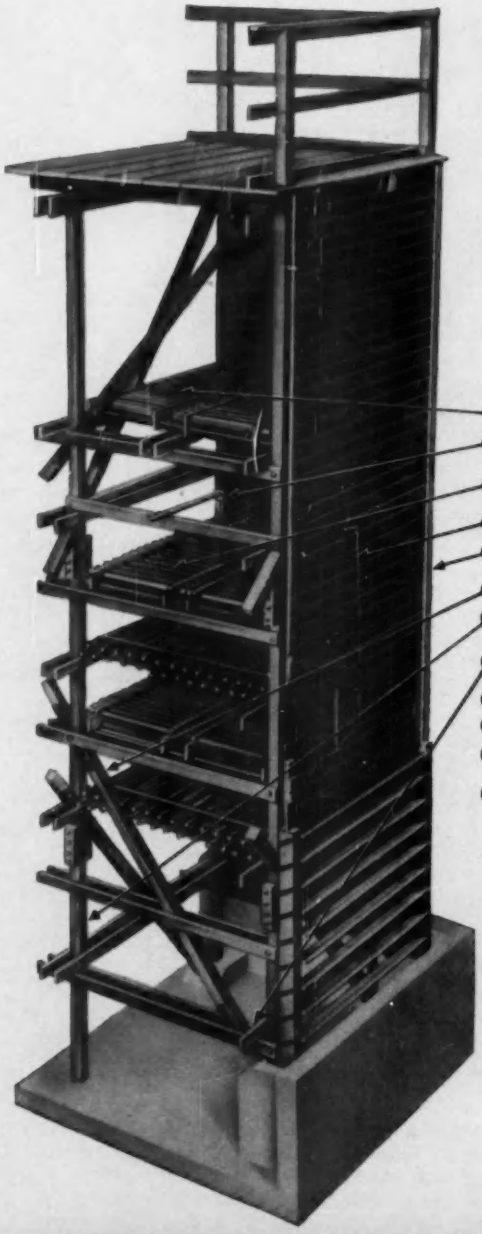

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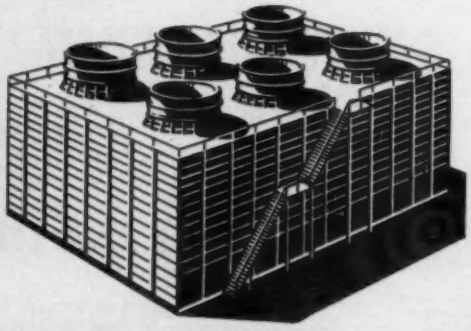

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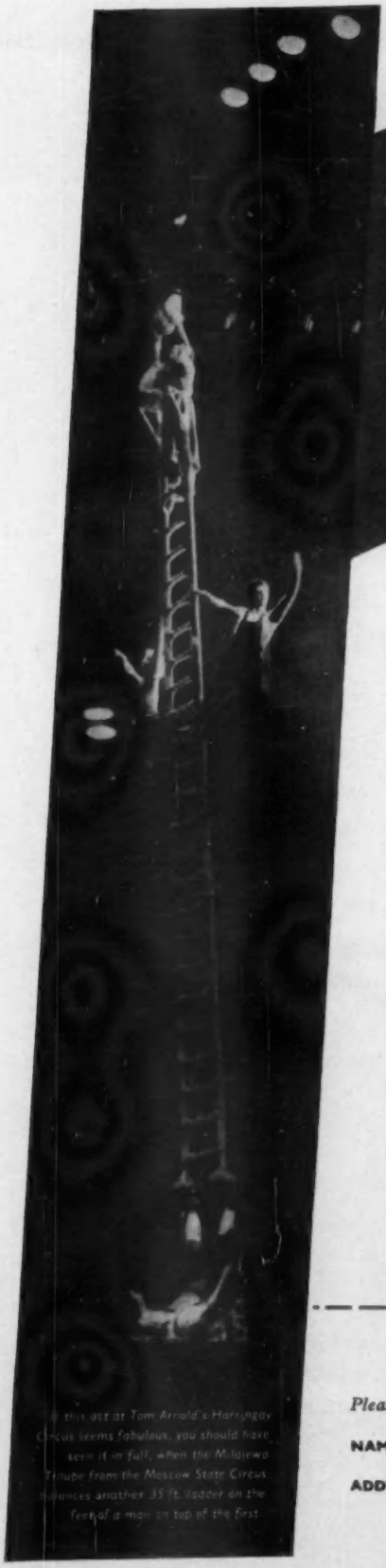

If this act at Tom Arnold's Harringay Circus seems fabulous, you should have seen it in full, when the Mikolewa Troupe from the Moscow State Circus balances another 35 ft. ladder on the feet of a man on top of the first

The Russian Steppes

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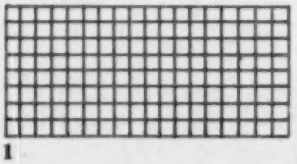
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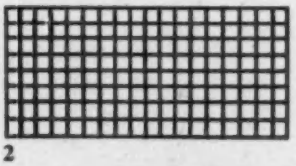
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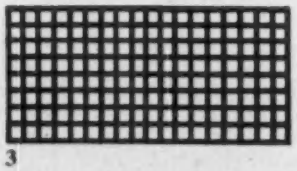
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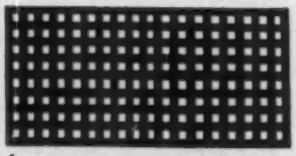
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The Ringlemann Chart

The Clean Air Bill is now law and it provides, inter alia, that the density of smoke emitted from an industrial chimney must not be denser than Ringlemann 2 for more than two minutes—see charts on left.

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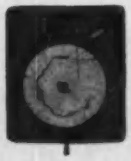

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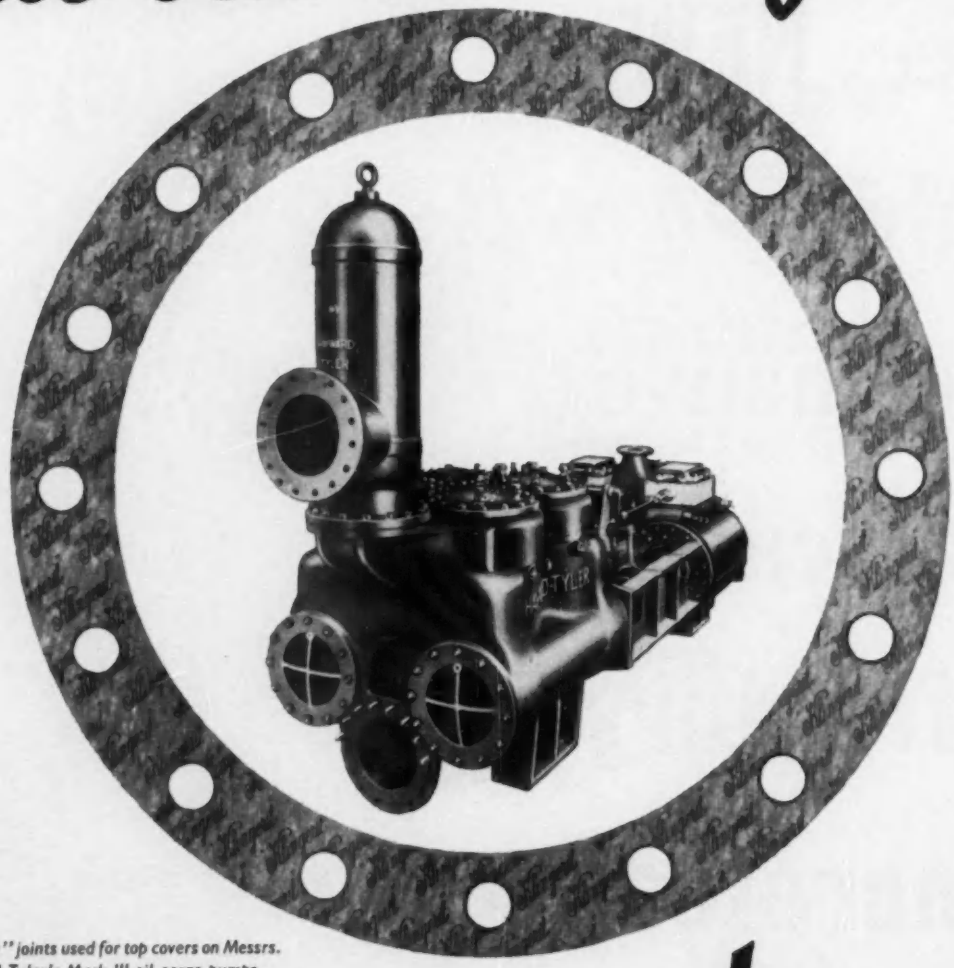

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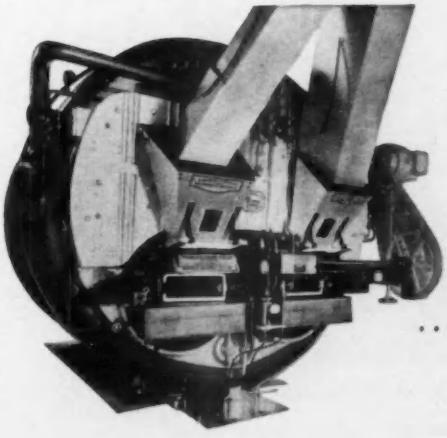

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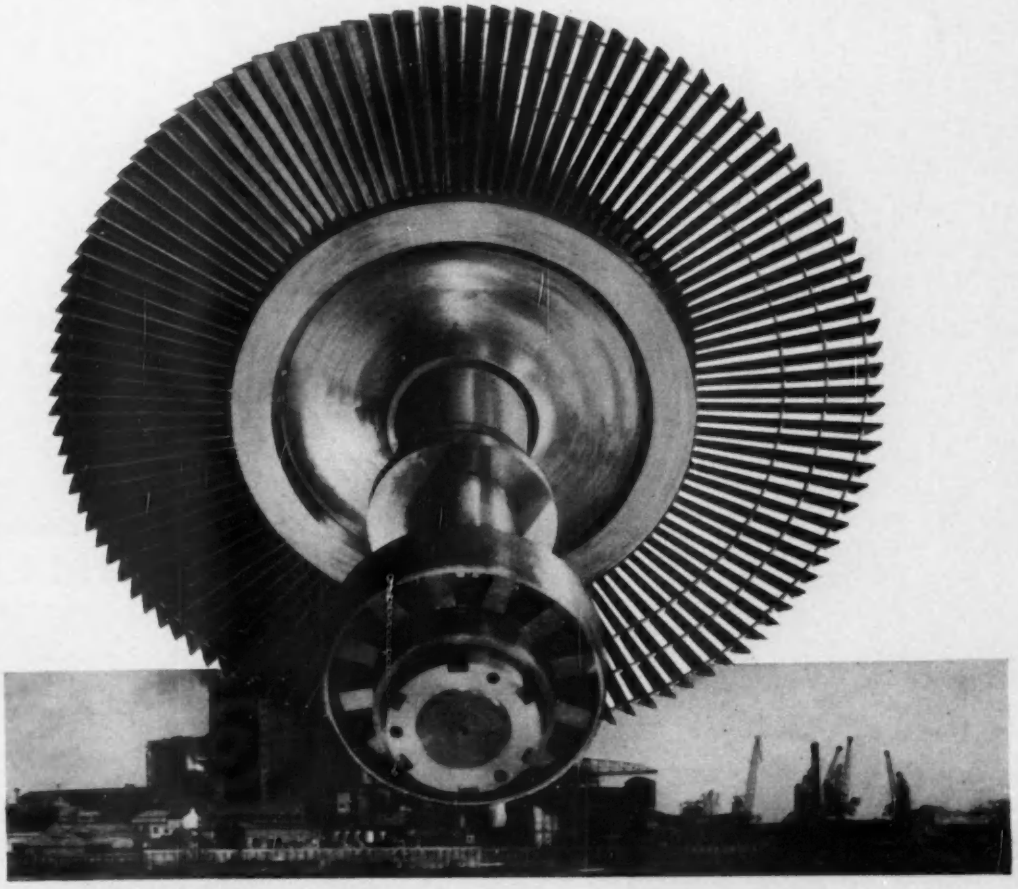

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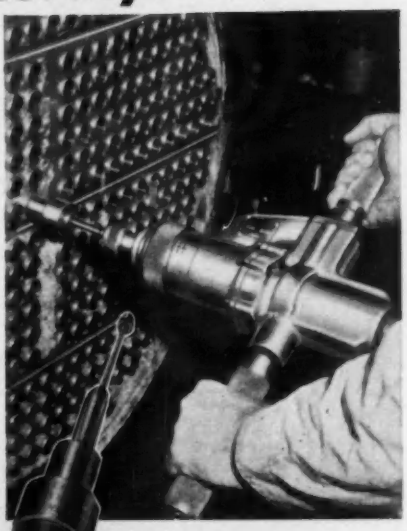

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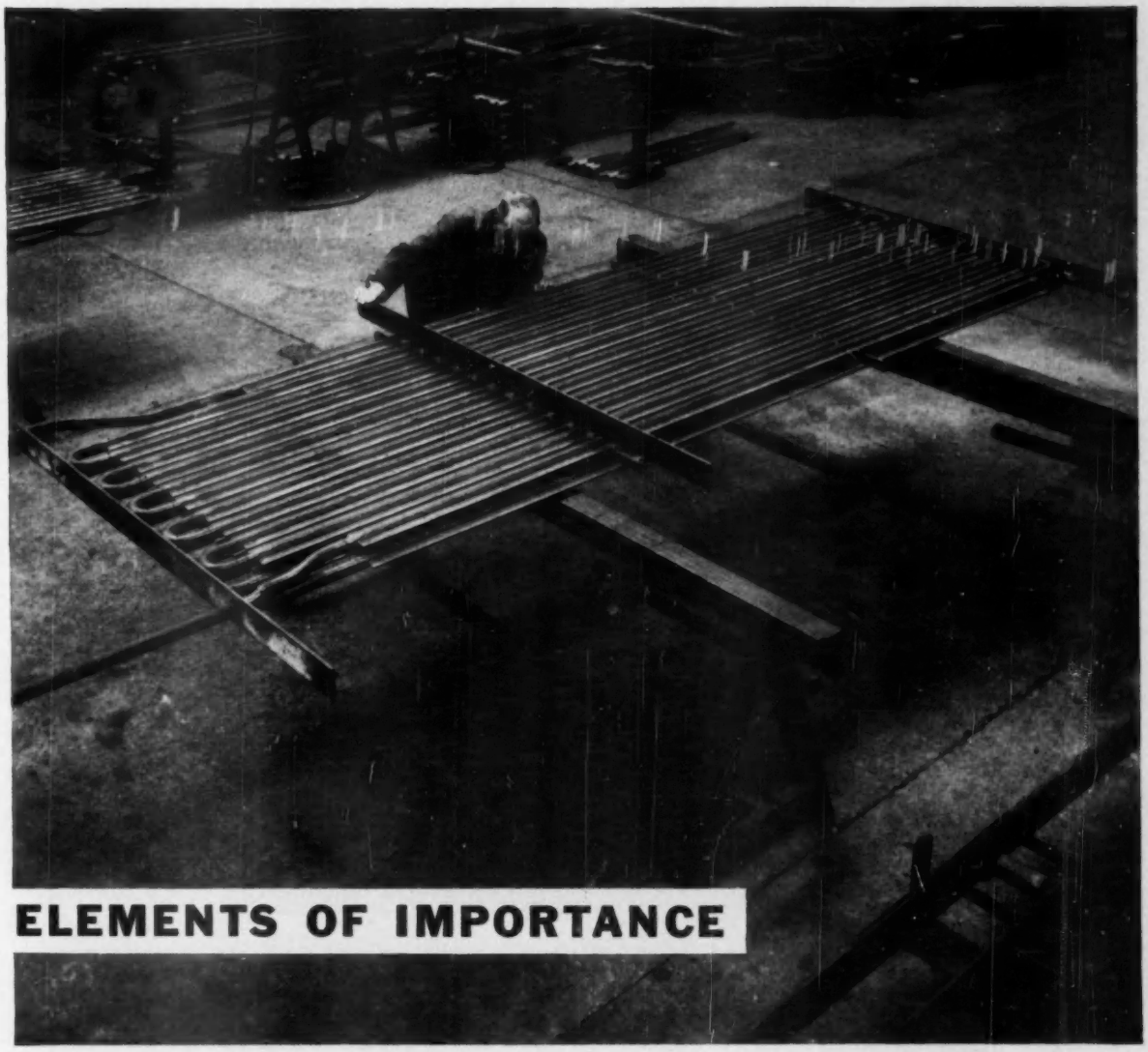

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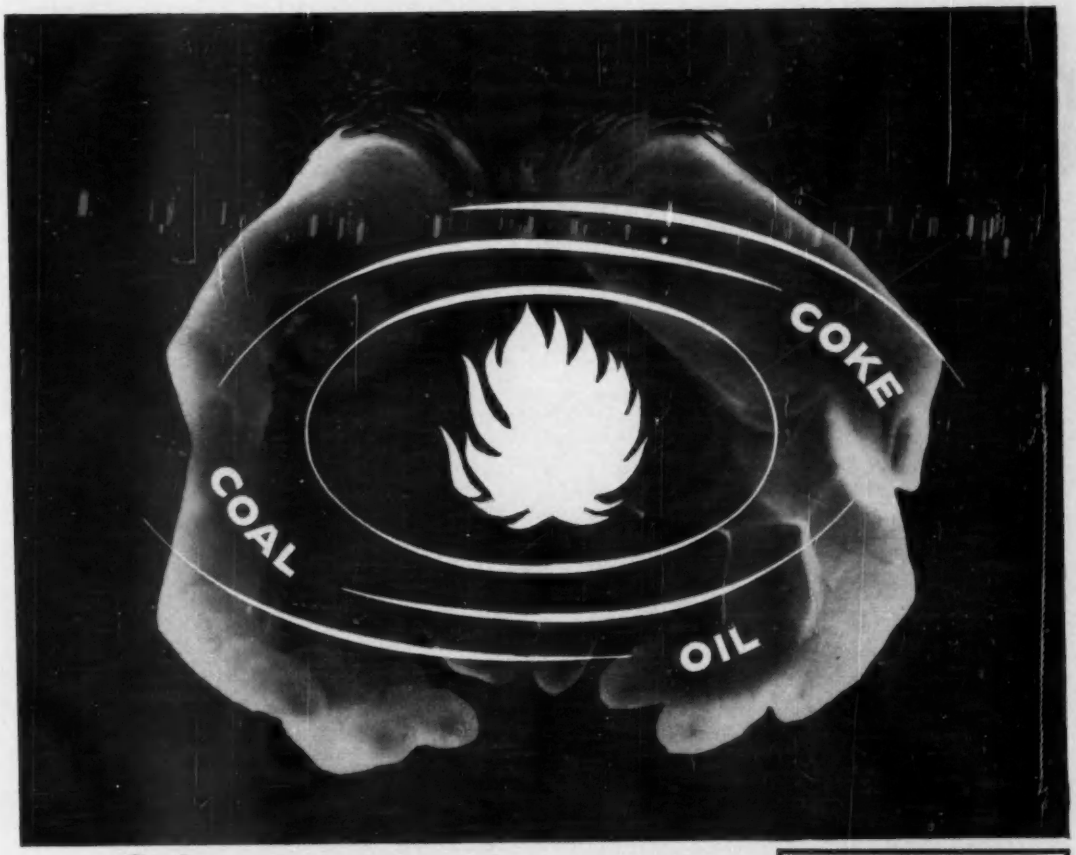

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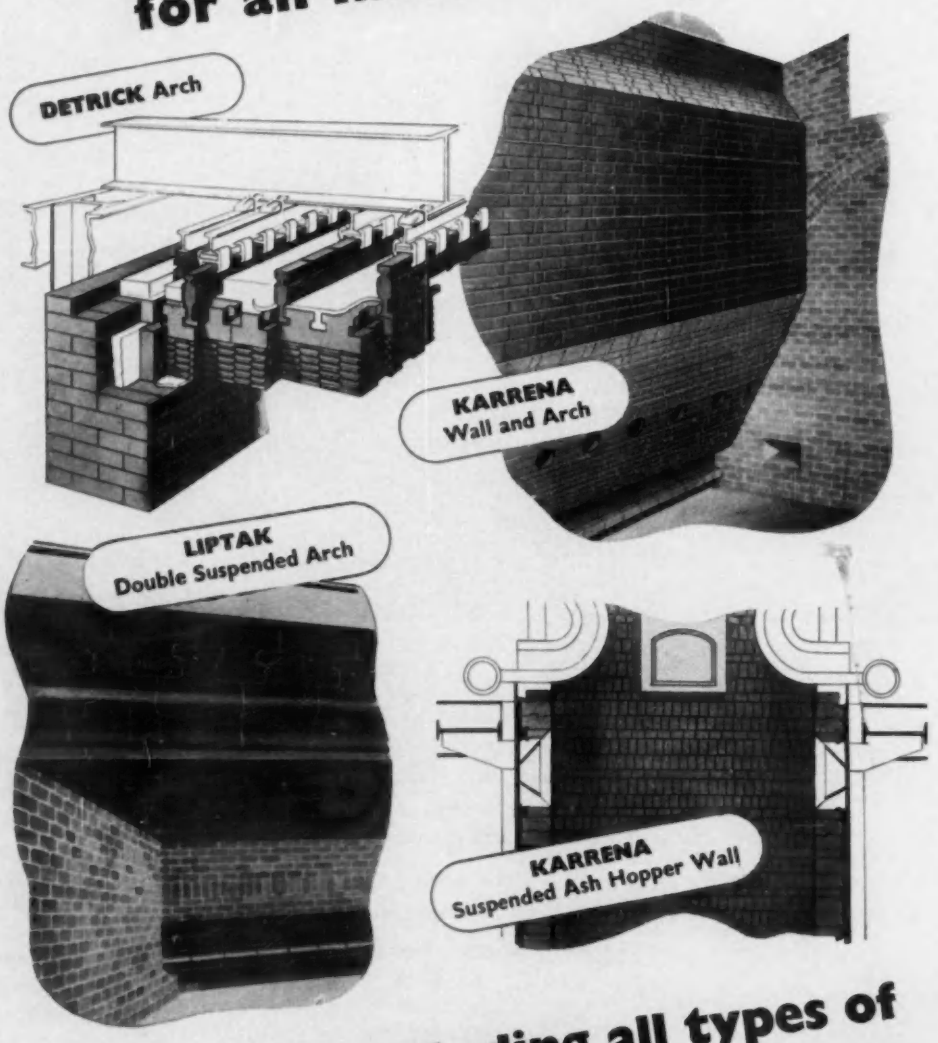

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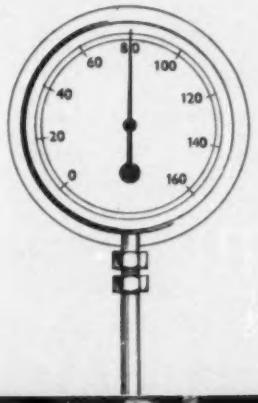

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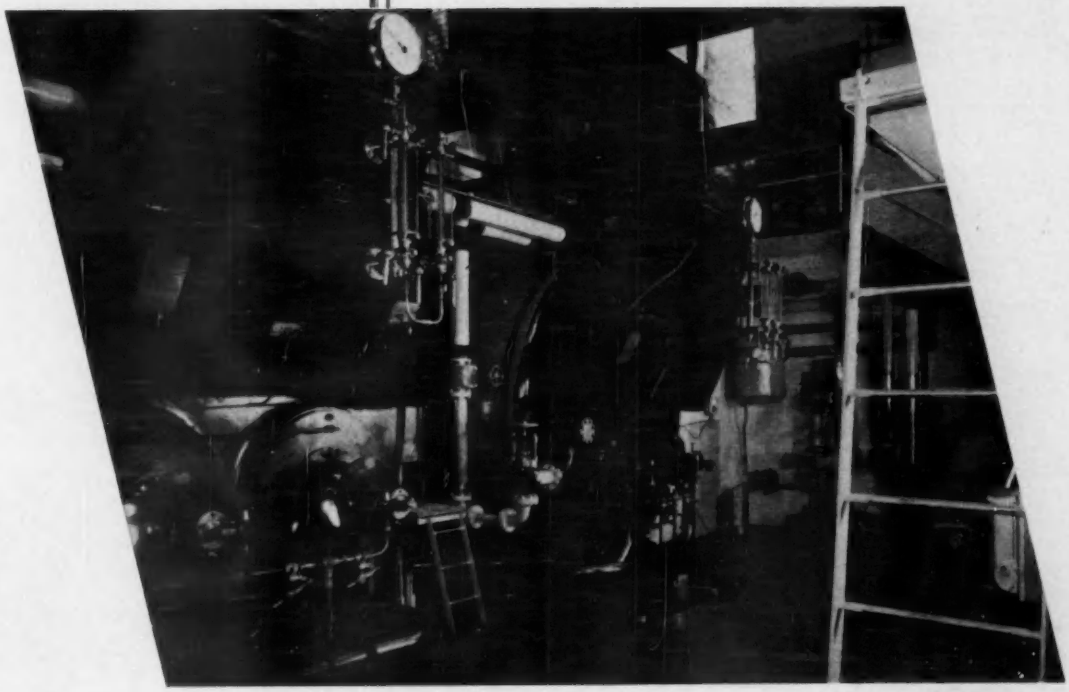

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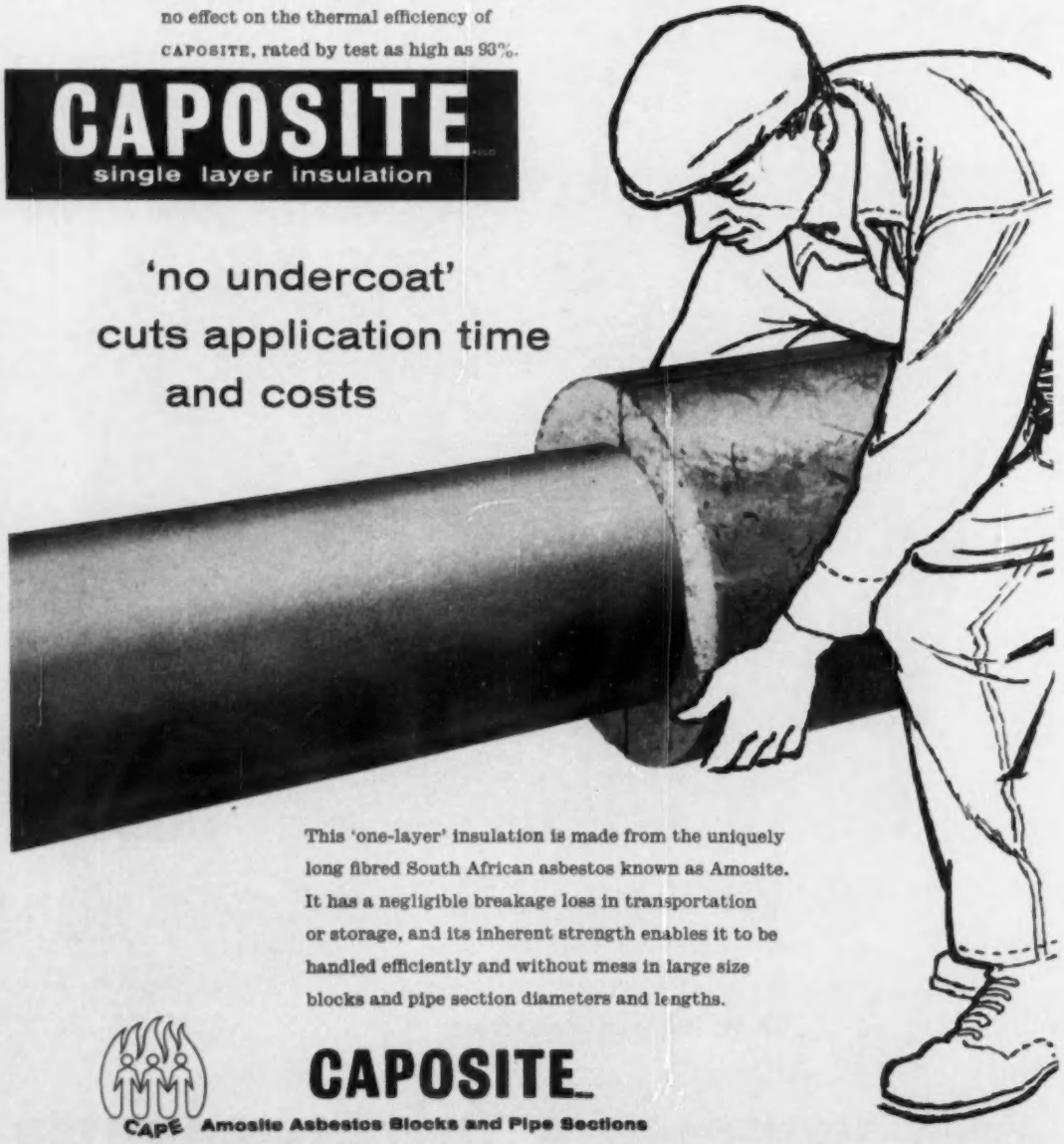

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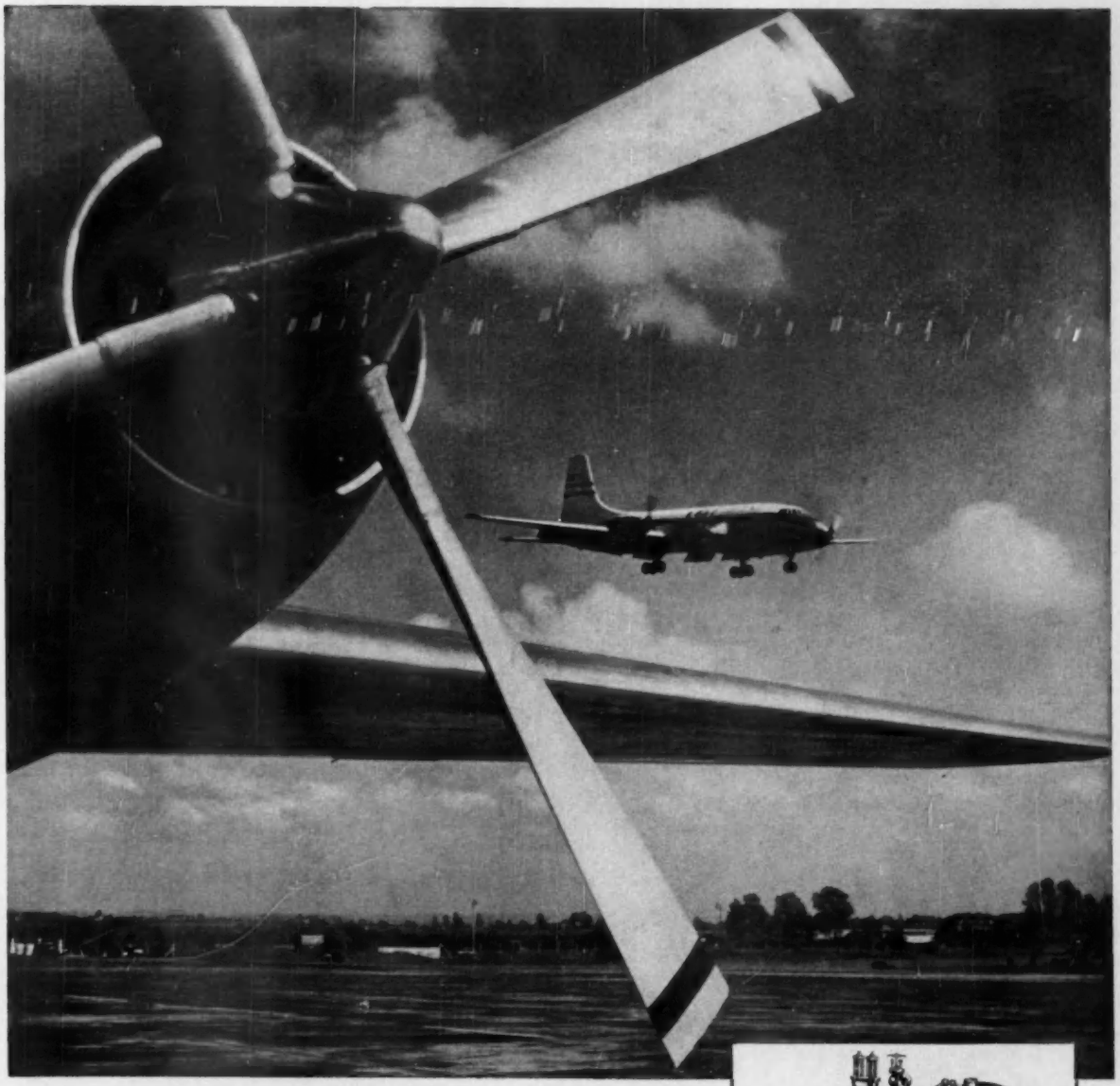

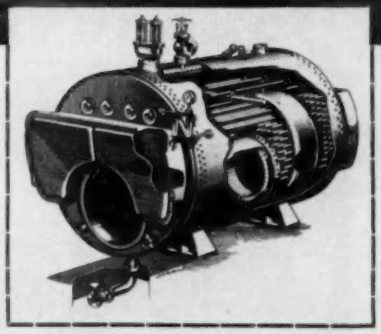

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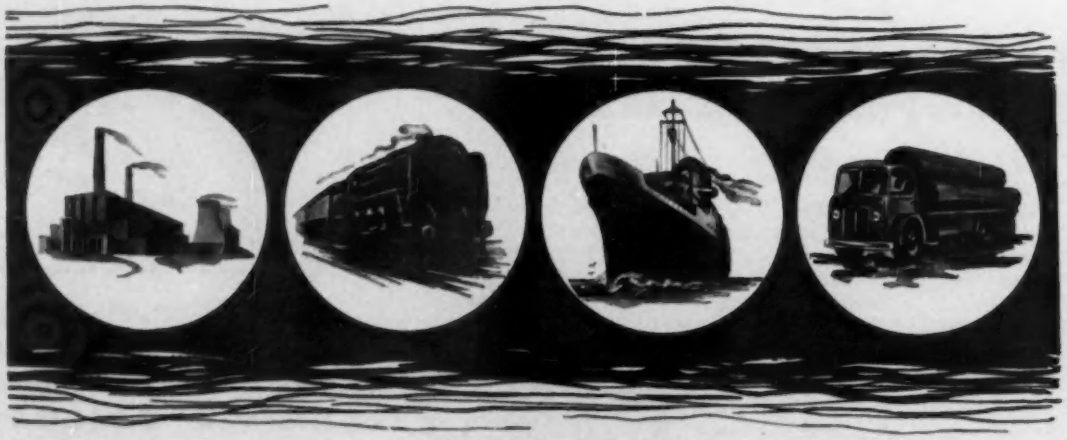

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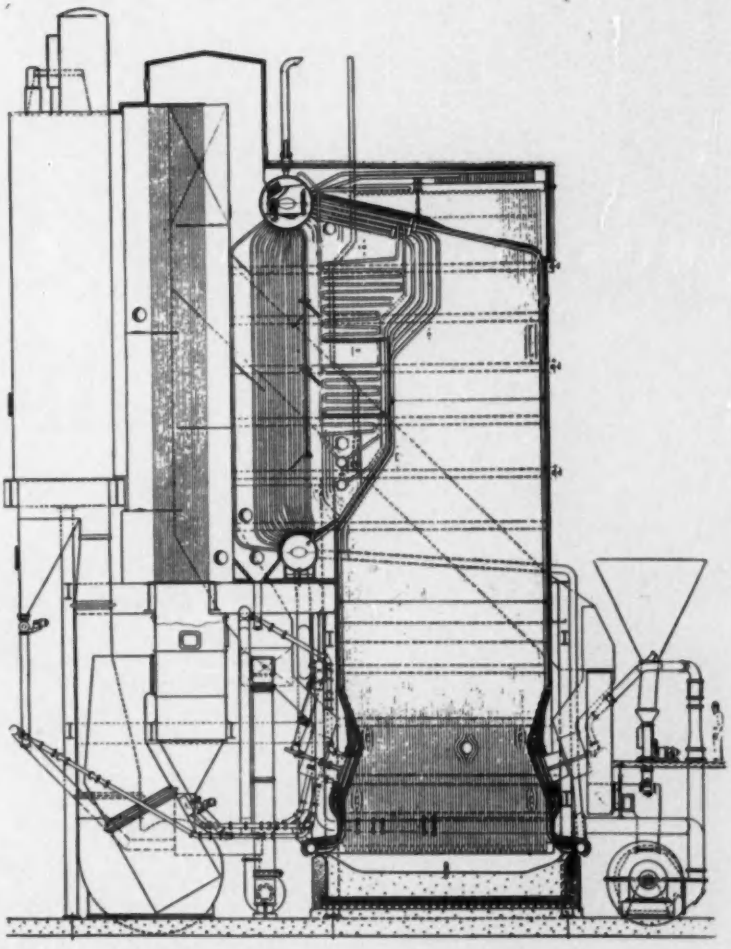

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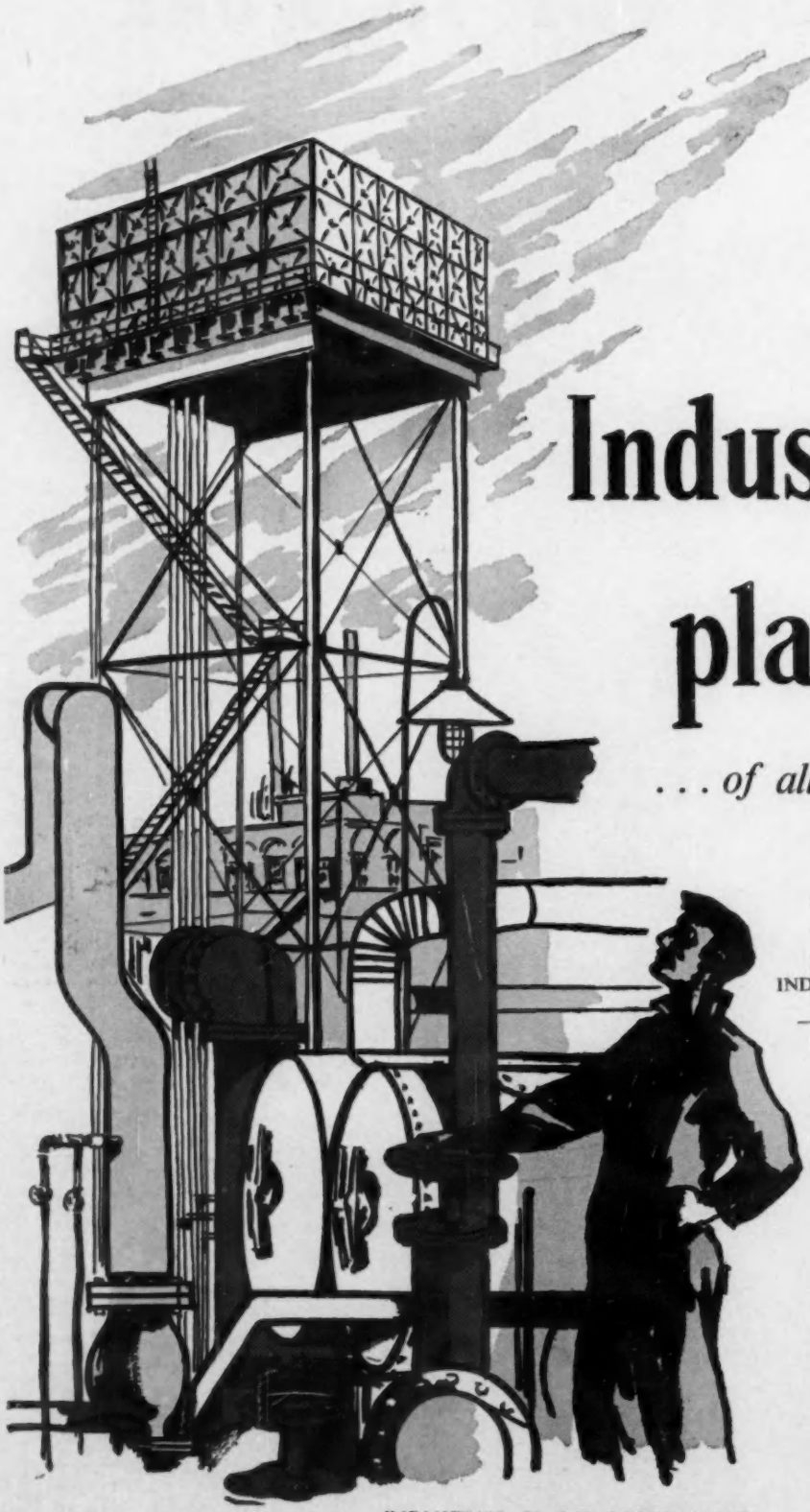

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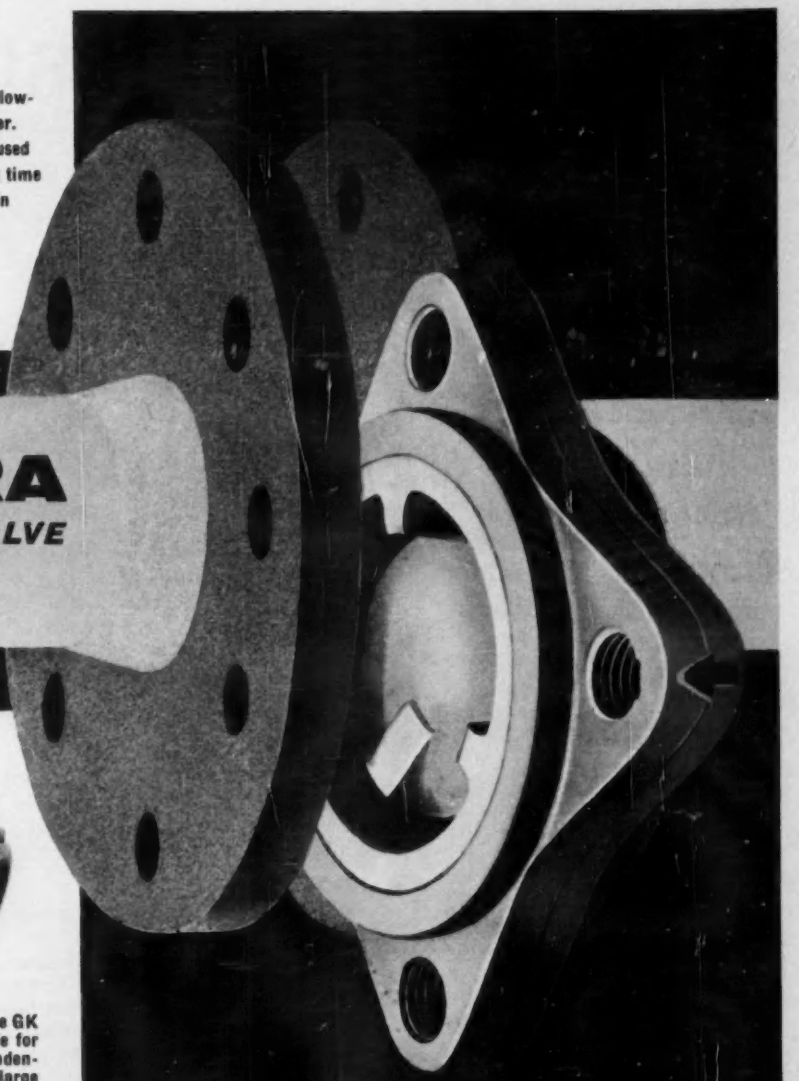

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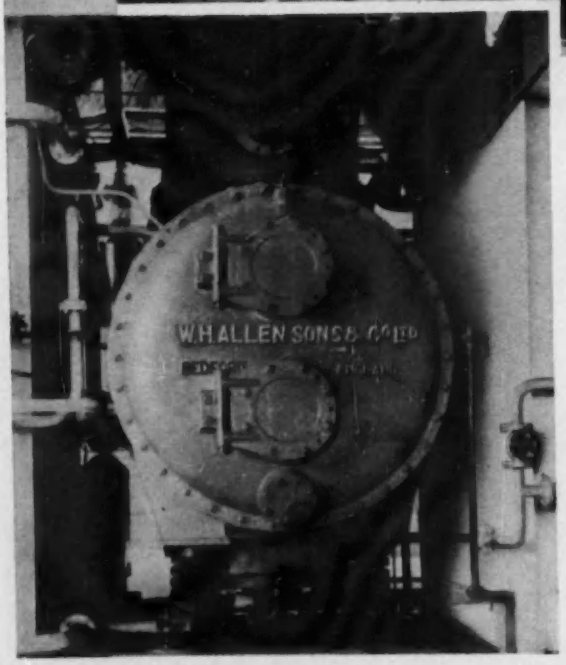

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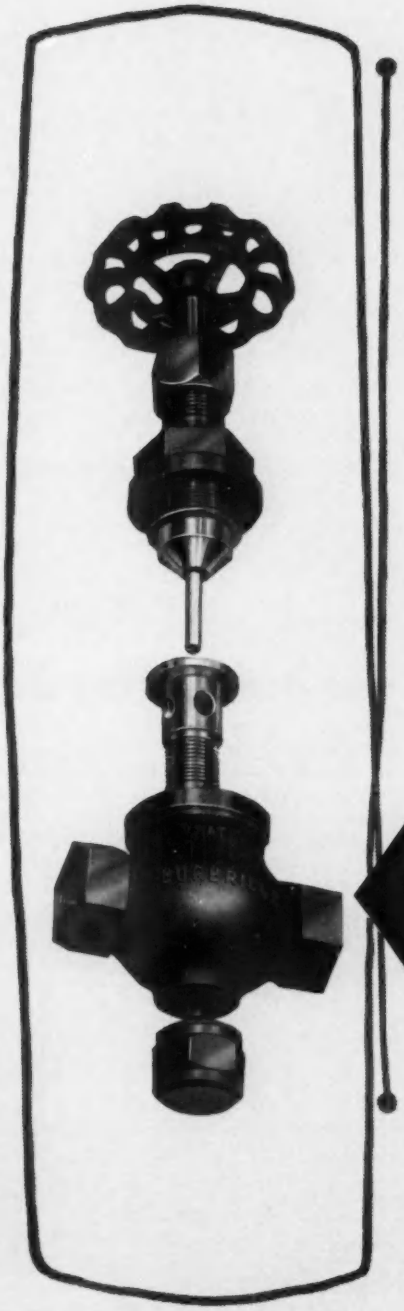

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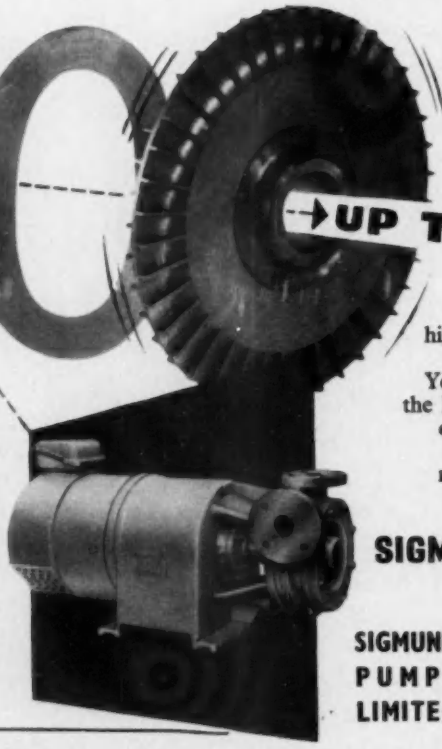

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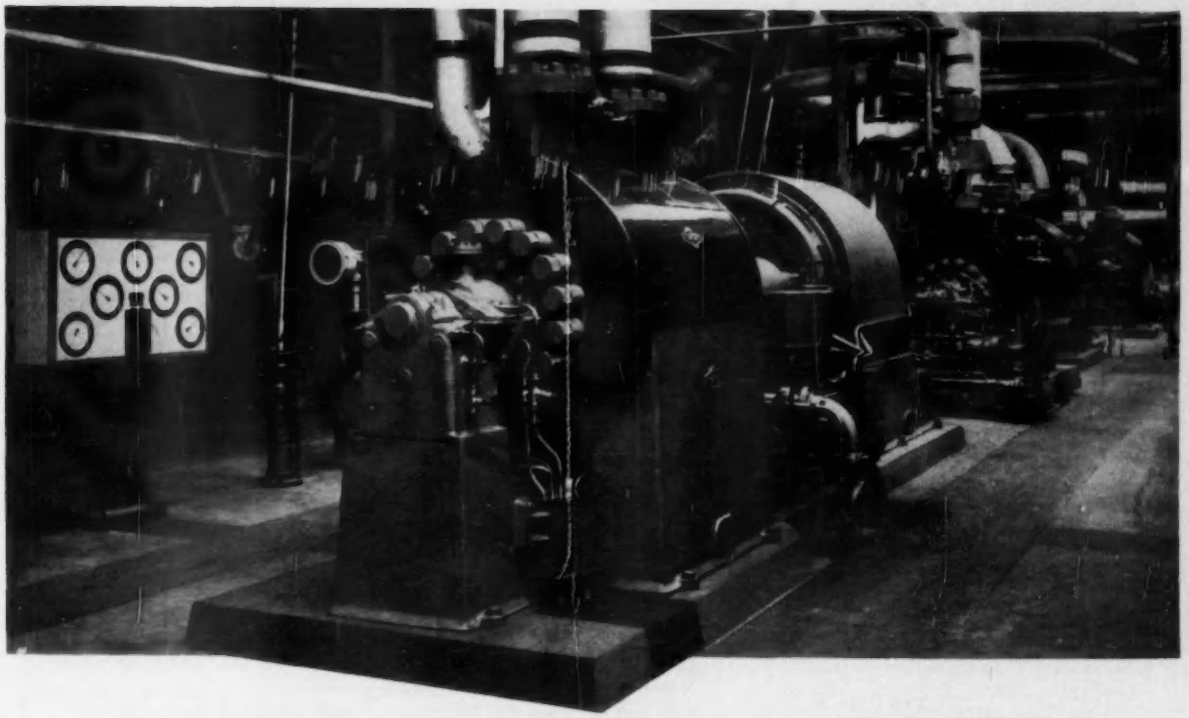

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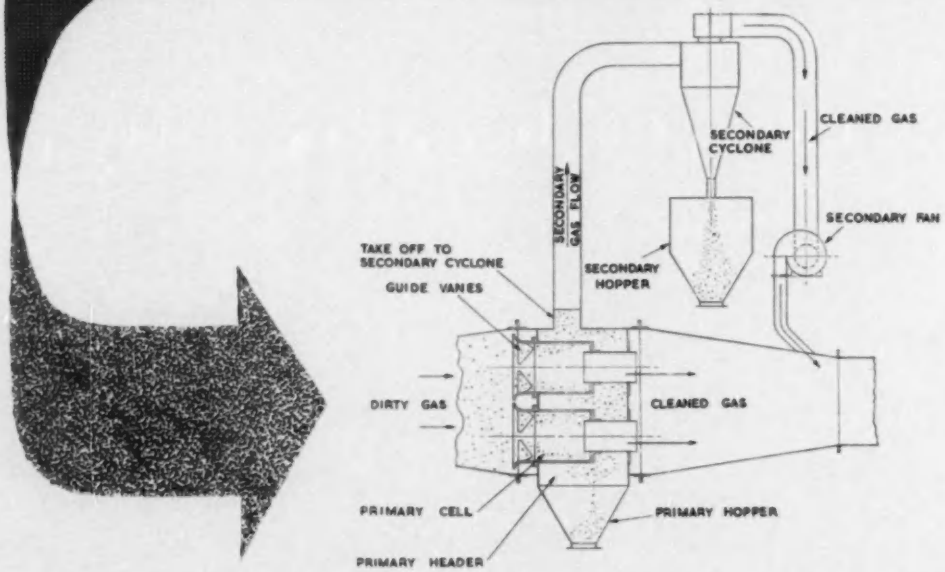

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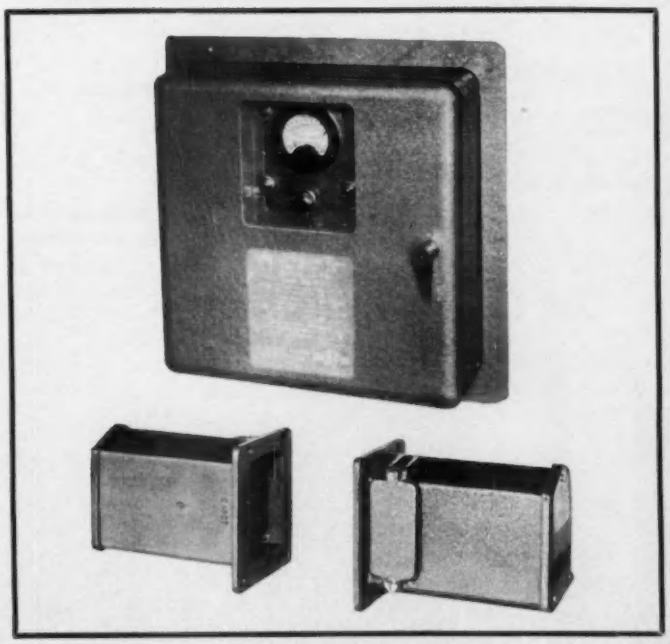
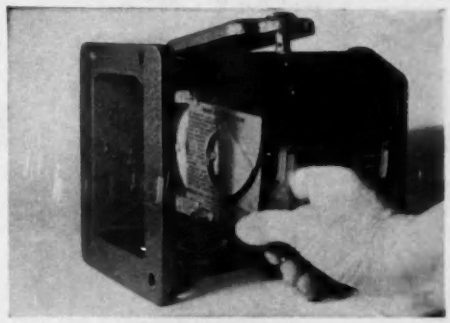
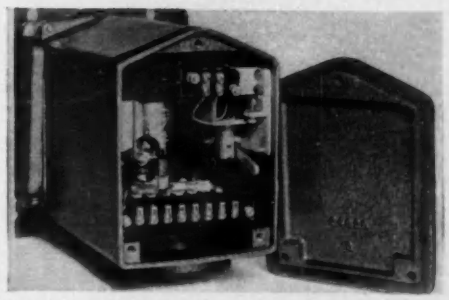
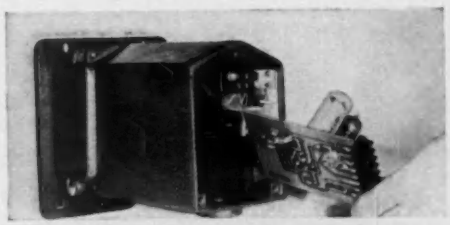
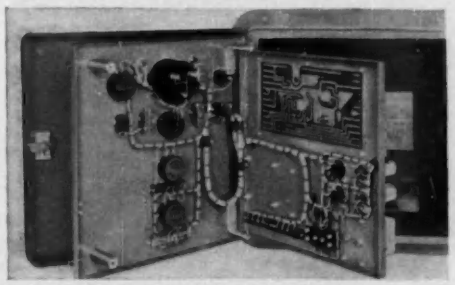






Calibration check by manual insertion of check slide or, in lower illustration of head with remote standardising unit, by push button from main unit.





Printed circuit in main unit and head for ruggedness. Head unit circuit easily removed without disturbing mounting of unit on stack.

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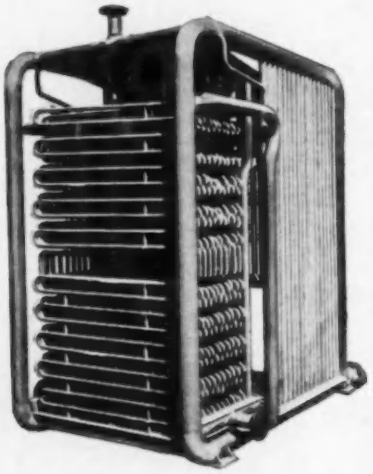

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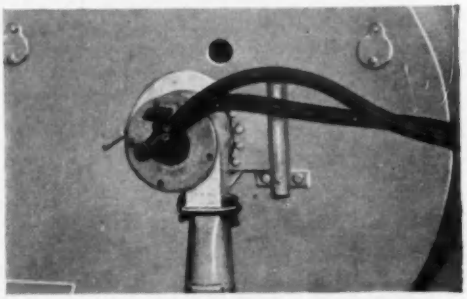

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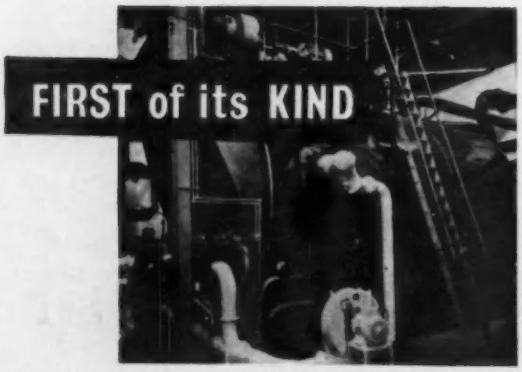

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Engineering and BOILER HOUSE REVIEW

THE OLDEST ESTABLISHED STEAM ENGINEERING PUBLICATION

MARCH 1958

VOLUME 73. No. 3

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The Editor will be glad to receive and consider original contributions, correspondence, etc., of a suitable nature for publication. Stamped and addressed envelopes should be enclosed for the return of any matter considered unsuitable

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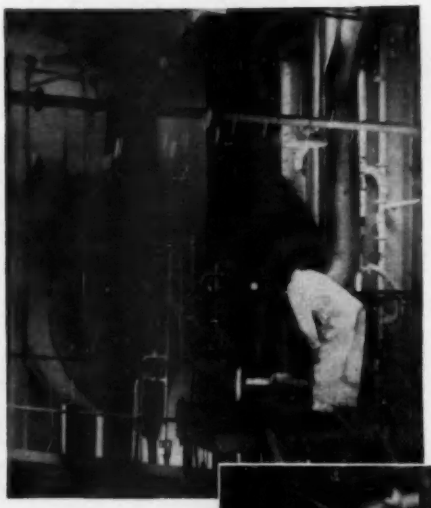
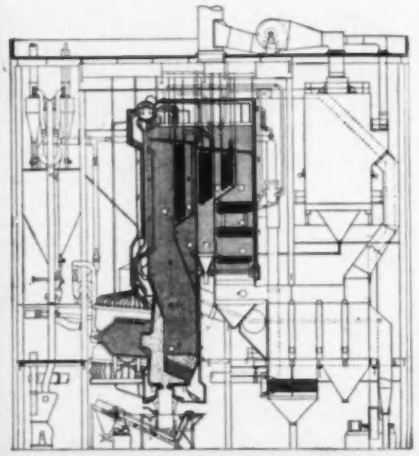
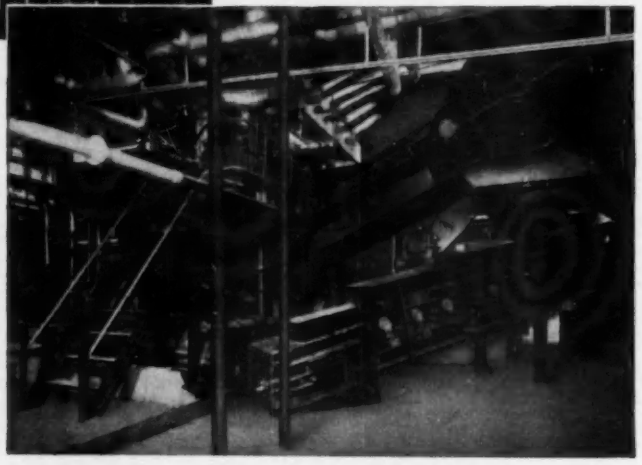
CYCLONE FIRING





(Right) The cyclone furnace, firing Britain's first Cyclone-fired boiler plant at I.C.I. Ltd. Kynoch Works.

(Lower right) View of slag extraction plant below the cyclone furnace.



solves the ash-disposal problem in large industrial boiler plant

THE Babcock Cyclone-fired 200,000 lb./hr. Radiant boiler in service at the Kynoch Works of Imperial Chemical Industries Limited, Metals Division, has operated consistently at an efficiency of nearly 90%, with an excess-air figure as low as 8%. Furthermore, although this boiler will operate satisfactorily on coal of such low quality as virtually to prohibit its use in other types of boiler plant, the major problem of ash-disposal is eliminated, the ash being discharged from the boiler as granular slag, easily handled and readily usable on civil works. Only about 8% of the total ash passes through the boiler and this is returned from the precipitator to the Cyclone furnace where it is reduced to slag. Tests show the dust burden of the exit flue gases to be only .033 grains per cubic foot.

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MARCH 1958

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NUCLEAR POWER PLANT DEVELOPMENT, 1946-1956

THE Melchett Lecture of the Institute of Fuel, and entitled " Nuclear Power Development:—Some experiences of the first Ten Years," was given by Sir Christopher Hinton in London on February 19th. Sir Christopher told for the first time the dramatic pioneering story of how British nuclear engineering reached its present position of world leadership within a space of about twelve years, after starting from nothing. He recalled that it was at the end of 1945 that it was decided to form the Atomic Energy Organisation which was to consist of a research group at Harwell, under Sir John Cockcroft, and a production organisation which he (Sir Christopher) was asked to take charge of. At that time he had no staff, no office accommodation, and practically no information. But fortunately he was able to arrange with I.C.I. Ltd. that the services of three of their engineers who had been associated with Sir Christopher both before and during the war should be made available to join him.

In August, 1946, only a few months after this embryo staff had started work, the McMahon Act was passed in America, stopping all technological information from the United States, except in certain limited fields of research. The McMahon Act withheld information on the design of the American reactors; and thus Sir Christopher and his associates had to think for themselves. In doing this, they were at least able to work out their own methods of approach, and produce results which led to this country's present position of leadership.

The original directive was to build a single graphite-moderated, water-cooled reactor for the production of plutonium, with plant for the manufacture of uranium fuel elements and other plant for the chemical extraction of the plutonium from them. It was decided to build the uranium metal factory on the site of a disused poison gas factory between Preston and Blackpool. Within a short time, decontamination of this factory from poison gas was completed, and construction work put in hand. The designers were faced with the problem of designing a plant for handling radioactive material on a scale of which there was no previous experience in this country.

On top of other difficulties and uncertainties was the problem of the toxic hazard of uranium. The danger of uranium dust on the skin of the hands or other parts of the body had to be guarded against; so had fire risks. Despite all difficulties, the first bars of uranium were finished on October 19th, 1948—two-and-a-half years after the first office had been opened at Risley (Lancs). This was surely a creditable performance—particularly in view of the fact that it was achieved by an entirely new organisation with no business connections, and one which most manufacturers regarded as an upstart for which there was no long term future.

It was originally proposed to meet the plutonium requirement in two stages:—the first stage by means of an air-cooled reactor which would virtually be a scaled-up version of the large Harwell reactor and which would be capable of producing half the amount of uranium required. The second stage would be to build a more highly-developed reactor cooled by gas under pressure, and working at a high enough temperature to allow for the generation of steam for electrical power generating purposes. This dual approach was turned down on account of the urgency of the national requirement for plutonium. Work on the gas-cooled reactor continued in collaboration with industry, and a complete scheme was worked out by the end of 1952.

Meanwhile it was necessary to proceed with the problem of meeting the plutonium requirement by the construction of reactors cooled by atmospheric air. This led to the construction of the two Windscale piles. The possibility of an occasional failure of fuel elements was always realised and that if this happened, uranium contaminated with fission products would be oxidised and carried up the chimney. American experience had shown that the products of combustion from damaged fuel elements were of comparatively large particle size, and might fall out on the factory site and surrounding land. For this reason air filtration plant had to be provided; but because construction of the plant had proceeded so far, it was impossible to put it anywhere except on the top of the chimney, which was completely re-designed to make this possible. Provision had also to be made to detect failure of fuel elements in the very early stages. It was decided to insert a moving monitor apparatus into the back of the reactor, which would sample rows of the 3,000 channels in turn.

" The major problems of the early years," said Sir Christopher, " arose from the fact that they were a small organisation working against an almost impossible timetable in a field in which they had incomplete knowledge. By 1953, when the Calder Hall reactors were put in hand, the organisation was much more solidly founded and much more broadly based. Although they were working to the limit of their available knowledge, this knowledge was much more extensive. This is even more true today now that the basis of the nuclear power plant industry has been broadened by the work of the industrial consortia, who are building reactors of established types for the Electricity Boards, while the Atomic Energy Authority goes on with the development of the longer term improvements to these reactors and the design of more advanced reactor types. In the early years, the team had to press on because only by doing so could they hope to meet the target date for the production of plutonium. If they were wrong they might fail to meet that date, but if they waited until all was clear there was no hope of meeting it.

" As an organisation grows in maturity and in size, this approach should become less necessary, but it inevitably becomes less possible. Research, development and large-scale trial must move sufficiently in advance of the industrial programme to enable progress to be made without accepting financial risks of such magnitude as to make it impossible to justify them."

Points and Pointers

INSTRUMENTS, ELECTRONICS & AUTOMATION EXHIBITION The 1958 Instruments, Electronics and Automation Exhibition—to be held at Olympia, London, from April 16th to 25th—will, it is stated, be one-third larger and also more important than the record-breaking 1957 show. The exhibits and stands will cover more floor space, there will be an increased number of exhibitors—including many new ones—and there will be an extensive International Section devoted to overseas exhibitors. The exhibits themselves will cover a wider field, for another trade association has joined with the five which originally staged the exhibition. Last year, its sponsors were the British Electrical and Allied Manufacturers' Association, the British Industrial Measuring and Control Apparatus Association, the British Lampblown Scientific Glassware Manufacturers' Association, the Drawing Office Material Manufacturers and Dealers Association, and the Scientific Instrument Manufacturers' Association of Great Britain—a group which in itself represented a majority of the major manufacturers responsible for the development of electronics, instrumentation and automation in this country. The scope of the exhibition has now been still further extended, by the participation of the Radio Communication and Electronic Engineering Association, representing a further important and specialised section of the industry. The 1958 home exhibitors' list includes over 250 of the leading firms in British instrumentation and electronics. A feature of this year's exhibition will be the extensive overseas section, in which will be represented over 100 leading manufacturers from many countries including the U.S.A., Germany, Austria, Denmark, Czechoslovakia, Switzerland, Hungary, Holland and France. These overseas exhibits will be on an impressive scale. The French industries alone, for instance, are to send between 30 and 40 exhibitors, who will contribute the show's largest individual stand, totalling nearly 4,000 sq. ft. From the United States, 48 manufacturers will be represented. One of the successes of the 1957 exhibition was a top-level conference, at which leading speakers from the scientific and industrial world expressed their views and made public for the first time details of many new instrument and electronic innovations. Like the exhibition itself, the 1958 conference will be international and will, therefore, provide a forum for an international exchange of views by leading scientists not only from Britain, but from many other countries throughout the world.

CHANGING TRENDS IN FUEL CONSUMPTION When Lord Mills (Minister of Power) announced recently the establishment of a committee to consider ways of improving co-operation between the Electricity Boards and the Area Gas Boards, he drew attention to the change in the pattern of fuel consumption since the war. He said that since 1948, while the consumption of coal had increased by only 10 per cent. and of coke by 15 per cent., that of gas had risen by 27 per cent., of oil by 91 per cent. and of electricity by 99 per cent. Whereas before the war gas and electricity had accounted for a quarter of the total fuel consumption, they now accounted for over 40 per cent. Lord Mills said that while a turning point had been reached with the advent of nuclear power, he had no doubt that coal would remain the basis of the fuel economy for many years to come. Nevertheless, with rising stocks of small coal, and the fall in oil prices, it may no longer be necessary to insist on maximum production of coal regardless of cost and it is reported that the National Coal Board are beginning to consider ways of curtailing marginal production. On the short view, current consumption of coal is running about 3 per cent. below that of last year. Nevertheless, the problem of limiting high cost production is by no means simple, since it has been estimated that out of approximately 10 to 12 million tons produced annually, from sub-marginal pits, about 60 per cent. consists of anthracite, house coals and other grades which are in heavy demand, while the existing heavy stocks comprise mainly small coal. Before formulating any major change in fuel policy, however, it must be remembered that the present situation follows two years of virtual industrial stagnation. A resumption of rapid expansion of industrial output might quickly change the general outlook. A very important factor contributing to the present unbalance of the supply and demand of different grades of coal is undoubtedly the fact that the differential between prices of large and small coals is insufficient, and it is expected that a new price structure involving greater differentials will be announced later this year.

THE 1958 POWER CONVENTION "Electricity and World Progress :—Britain's Contribution" has been selected as the theme of the tenth British Electrical Power Convention, which will be held at Brighton from June 16th to 20th, under the presidency of Sir George Nelson, Bt., LL.D., F.C.G.I., D.I.C., M.I.Mech.E., M.I.E.E. As in former years, an electrical exhibition will be held in conjunction with the convention and it will be opened by the president on the evening of Monday, June 16th. The first session of the convention will be held in The Dome, on the morning of Tuesday, June 17th, when the delegates will receive a civic welcome from the Mayor of Brighton. Sir George Nelson will then deliver his presidential address. On Tuesday afternoon a paper on "The Development of Nuclear Energy for Electricity Supply in Great Britain" will be presented by Sir Christopher Hinton, K.B.E., F.R.S., D.Sc., M.A., M.Inst.C.E., M.I.Mech.E., M.I.Chem.E., chairman of the Central Electricity Generating Board. Wednesday's proceedings will begin with an address on "The Development of Nuclear Energy for Electricity Supply Overseas," by Sir Claud Gibb, K.B.E., F.R.S., D.Sc., M.E., M.I.Mech.E., chairman

and managing director, C. A. Parsons & Co. Ltd. " Britain's Part in Electrical Development Overseas " will be the subject of a paper on Wednesday afternoon by Mr. H. J. Beard, M.I.E.E., a partner in the firm of Messrs. Merz and McLellan, consulting engineers. Attention will be centred on hydro-electric matters and the domestic use of electricity in Thursday's proceedings. " British Hydro-Electric Plant and World Power Requirements " is the title of a paper to be presented by three members of the staff of The English Electric Co. Ltd., Mr. J. C. Beverley, M.A., A.M.I.Mech.E., A.M.I.E.E., Mr. E. G. Teasdale, B.A., and Mr. A. Wilmot, B.Sc. (Tech.), D.I.C., A.M.I.Mech.E. They will trace the changes in the magnitude and nature of the demand for hydro-electric power plant in recent years for both the United Kingdom and the world markets, and also with the requirements of pumped storage. They will show how British manufacturers met these demands and will emphasise the ability of all British concerns to deal with all aspects of hydro-electric stations. On Thursday afternoon Mr. J. I. Bernard, B.Sc., M.I.E.E., director and secretary, British Electrical Development Association, will speak on " The Development of the Electrically Equipped Kitchen." In the evening, the convention's annual dinner and dance will be held in the Corn Exchange. The popular " Electrical Forum," at which a team of experts answer questions on electrical matters, forms the concluding session of the convention on Friday morning, June 20th. This will be followed by the annual general meeting, at which officials for 1958/9 will be elected and the venue of the 1959 convention decided.

EMISSION OF DARK SMOKE As from June 1st it will be an offence, (with fines up to £100), to emit dark smoke from chimneys. This is the principal effect of an Order laid before Parliament by Mr. Henry Brooke, Minister of Housing and Local Government, and published on February 6th. The Order names June 1st, 1958, as the second appointed day for the Clean Air Act, 1956, and on that day all the remaining provisions of the Act will be brought into operation. The dark smoke ban will apply equally to factories, shops and offices and the funnels of ships and railway locomotives. House chimneys will be subject to it, but in practice they rarely produce " dark smoke," which is defined as smoke as dark as or darker than Shade 2 on the Ringelmann Chart. The Act allows certain defences in the event of proceedings, e.g., if it can be proved that dark smoke was solely due to lighting up a furnace from cold or to mechanical failure. In addition to the ban on dark smoke, the Clean Air Act will require a reduction in emissions of grit and dust from June 1st. After that date all new furnaces installed for burning pulverised-fuel, or more than one ton an hour of other solid fuels, will have to be equipped with grit and dust-arresting plant approved by the local authority. In the case of other new and existing furnaces, except for small domestic boilers, failure to take practicable steps to minimise grit and dust will be an offence. Much of the Clean Air Act has been in force since the beginning of 1957, including powers enabling local authorities to establish smoke control areas in which householders must burn smokeless fuel. There has been some fear expressed recently that it would be difficult to create these areas in mining districts because miners would be required to burn smokeless fuel instead of concessionary coal. It has been stated officially that the National Coal Board have now agreed to buy back concessionary coal from any miner whose house is included in a smoke control area.

NEW FACTORY FOR C. A. PARSONS & CO. LTD. It is announced that C. A. Parsons & Co. Ltd. have authorised work to be commenced on the development of a 109-acre factory site at Longbenton, near Newcastle upon Tyne. The first section of the work will consist of the building of light engineering workshops at a cost of £100,000. Sir Claude Gibb, K.B.E., chairman of the company, stated recently that despite a vast amount of capital already spent on developments and extensions of the company's works at Heaton and Walkergate respectively, the manufacturing facilities were still inadequate to meet present needs. Increased pressure on space was due to the rapid growth in the capacity of turbo-alternator sets and associated equipment, which was the basis of the firm's operations. Little more than ten years ago, the average size of turbo-alternators manufactured by the company was 22-MW and the largest units were 60-MW machines. Today, the average size was 150-MW and the largest 300-MW. Sir Claude added, the company had submitted a tender for what would be the largest turbo-alternator set in the world, viz.: 550-MW. With the building of the new workshops at Longbenton, the increased available space at the Newcastle works would permit the handling of larger components. Simultaneously with the first stage of the Longbenton development scheme work would begin on the construction of a heavy engineering workshop at Walkergate, and this will, it is estimated, cost £250,000. Land at Longbenton was, we understand, obtained several years ago, but development of the site was postponed about two years ago when the company proceeded instead with a £5 million extension at the company's present new works. Heaton and Walkergate works together now cover an area of approximately 55 acres and employ about 7,000 people. This figure is double the number employed by the company in 1946. It is interesting to note that the Heaton (Newcastle) works were founded by Mr. (later Sir Charles) Parsons, in 1889. The works site was approximately two acres in extent, with a single workshop covering a floor area of about 9,000 sq. ft. The entire staff numbered 48 persons. The first turbines produced were of the non-condensing type, but in 1891 Parsons produced the first condensing turbine of 100-kW capacity. This machine, which was subjected to the most stringent tests, was found to have a steam economy equal to the best reciprocating steam engine of the day. By 1900, sets of 1,000-kW capacity were being built, and in 1912 a turbo-alternator with an output of 25,000-kW, by far the largest and most efficient in the world at that time, was designed and constructed at the Heaton Works. This machine was installed in the Fisk Street power station of the city of Chicago and it proved to be so successful that in 1923 Parsons was entrusted with the contract for the design and construction of a 50,000-kW set for the same city. Sir Charles Parsons died in 1931, but he had lived to see the reciprocating engine completely superseded by the turbine for central power station duties.

60-MW PLANT CONSTRUCTED BY THE SOUTH OF SCOTLAND ELECTRICITY BOARD WITH BOILERS TO BURN SLURRY OR FILTER CAKE FROM WASHERIES OF NEARBY COLLIERIES

Barony Power Station

BARONY power station, of the South of Scotland Electricity Board, was formally commissioned towards the end of last year, by the Rt. Hon. J. S. Maclay, C.M.G., M.P., Secretary of State for Scotland. The boiler plant in the station has been expressly designed to burn large quantities of the waste known as " slurry " when recovered from settling ponds at the older types of coal-preparation plant, and as " filter cake " when separated from washing effluents by vacuum filtering in the more modern coal-preparation plant at the adjacent Barony colliery, and from a group of colliery washeries within a 25 mile radius of the station.

Disposal of this sticky, putty-like material of high ash and moisture content has for many years been a serious problem. Before 1939, when good class coal was plentiful and comparatively cheap, the slurry was dumped in unsightly ponds. But today the still increasing application of machine mining, necessary though it is in order to increase coal production, has resulted in a higher proportion of dirt and fines being brought to the surface, necessitating coal-preparation plant to suit market requirements of coal. While a certain proportion of the fines removed by coal-preparation plant can be marketed, there is always the residual slurry—hitherto regarded as waste, which is not only unsaleable, but is actually difficult to dispose of. According to recent estimates there is more than six million tons in slurry ponds in different parts of the country, and the amount is still increasing.

Many confident statements have been made concerning the ability to burn slurry, but most of them are only justifiable for a particular definition of " slurry," which may vary from one district to another. East Midlands slurry, for example, might more correctly be called " fines " ; it is a grade of coal which varies in size from ½-in. to 0, and, as such, presents no insuperable difficulty in either handling or burning. But the slurry in the immediate Barony area, which is grabbed from slurry ponds after settling from the wash-water, and which contains up to 40 per cent. of moisture, has hitherto been regarded as completely worthless. As the slurry or filter cake is frequently encountered in the form of a paste with the consistency of putty, the main problem, until recently, concerned the handling of the material, rather than in actual combustion.

It is generally recognised that the secret of handling slurry successfully is to keep it continuously on the move. Between recognising this principle and translating it into practice there is a very wide gap, since it is necessary to devise special techniques. Babcock & Wilcox Ltd. have paid special attention to the problems involved in this continuous handling without the use of bunkers or chutes of normal design, which are useless for handling a material with the characteristics of slurry. As a result, suitable plant has been designed and installed by the company at Barony.

The station comprises an initial installation of two 30-MW turbo-alternators, and four 150,000 lb./hr. boilers, utilising slurry as fuel, either with or without an admixture of slack coal, which can also be used by itself to carry the steam load as a temporary measure. The installed capacity of 60-MW, small by modern standards, was determined by the amount of fuel which would be available from the surrounding group of collieries.

Character of site

In determining the general location of the site for the station, the dominant factor was, of course, its proximity to the large modern coal-preparation plants now being constructed in the area by the National Coal Board. In view of the fact that the station was to be built close to Barony Colliery, special regard had to be paid to the

possibility of ground subsidence as the result of the increasing extent of the underground workings in the colliery. It was, therefore, decided that in order to ensure that the power station buildings and plant, or rather their foundations are protected, a pillar of unworked coal, or "pillar of support," as it is commonly known, was left, under the actual station buildings. The station site, which has an area of about 24 acres, is situated just off the Ochiltree-Auchinleck road, and approximately 13 miles west of Ayr. Railway connection from the London-Glasgow line into Barony Colliery already existed, and thus it now also serves the power station.

Main building

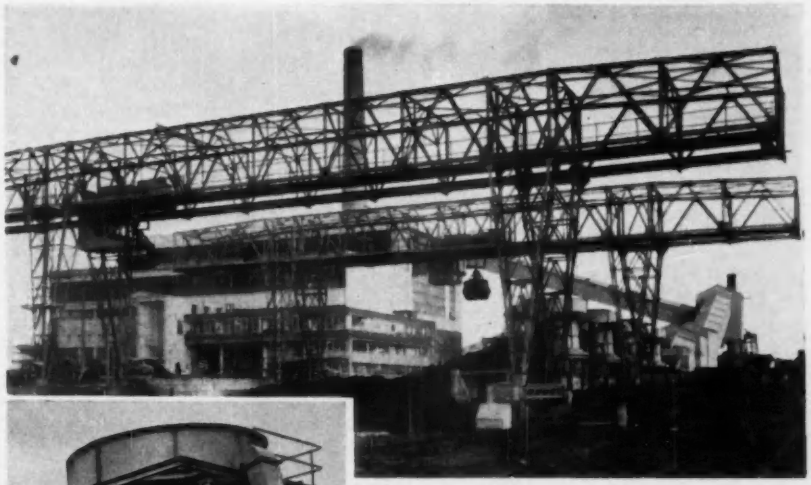
The main building, which houses the two 30-MW generating sets and the four boilers, is about 216-ft. square and 100-ft. high to the top of the boiler house roof. To the north of the building are two 200-ft. high cooling-towers which are of reinforced-concrete construction and were built by Bierrum and Partners Ltd. To the south and south-west respectively, are the fuel and ash-handling plants, while to the rear and east of the boiler house, electrostatic precipitators, supplied by Sturtevant Engineering Co. Ltd., and operating in conjunction with Howden mechanical-type dust-collectors are connected to the flue duct outlet of each boiler unit, and to the single 265-ft. high reinforced-concrete chimney which was built by Tileman & Co. Ltd.

Fuel-handling plant

The fuel-handling plant, supplied by Babcock & Wilcox Ltd., was specially designed to overcome all the inherent disadvantages of the fuel, in that, owing to its wet and sticky nature, it cannot be "tipped" like small coal, but has to be grabbed out of railway wagons, or removed by rams from specially-equipped road vehicles in which it is delivered to the site. It is hoisted in the grabs of two Goliath travelling cranes each of 4-tons capacity. These cranes span the fuel storage area, their gantries being extended over the railway tracks and rotary hoppers on one side, and over reception hoppers for road-borne fuel on the other side. The storage area is arranged to hold approximately 4,000 tons, with a maximum depth of 20-ft. at the centre. Slack is handled by the same methods, there being storage space for about 550 tons.

Generally, the slurry is deposited in the storage area to allow the water to drain off until the moisture content is 30 per cent. or less. It is then grabbed into any of the four rotary hoppers, each of 35 tons capacity, which feed the first of a system of belt conveyors by which it is transported via a mixer house to the boiler house.

The rotary hoppers, which were made by Babcock & Wilcox Ltd., are really the heart of the handling scheme. They enable the slurry to be kept moving and to be discharged in controlled quantities without difficulty, in the same manner as graded coal is fed from an ordinary bunker with a vibratory feeder. The hopper has sloping sides, with a reverse batter, and the base takes the form of a motor-driven rotating table; there is a fixed skirt carrying a plough which, as the table rotates, continuously cuts off the slurry in slices which fall on to a conveyor belt. The main design feature of the hopper, however, is that the body itself is mounted on heavy roller tracks and is free to rotate, thus avoiding the continuous shearing action which would otherwise take place between the sticky slurry and the hopper sides, and which would not only require very high motor power, but might easily result in the hopper becoming jammed with a mass of stationary material skidding on the rotary table instead of revolving against the plough. Movement of the plough is controlled hydraulically, the maximum opening giving a throughput rate of 80 tons/hr. As mentioned above, the slurry is conveyed from the rotary hoppers to a mixer house. This latter, while not essential to the scheme, is a worthwhile refinement since it enables different grades of slurry to be fed from different rotary hoppers in any desired proportions and intermittently mixed, and to mix slurry with dry, fine coal before being passed to the boiler house. The slurry enters the top of the mixer house in which there is a rotating paddle



(Above). The two Babcock & Wilcox 4-ton Goliath grab cranes, and beyond them the four 40-ton rotary slurry hoppers feed conveyors leading to the boiler house.

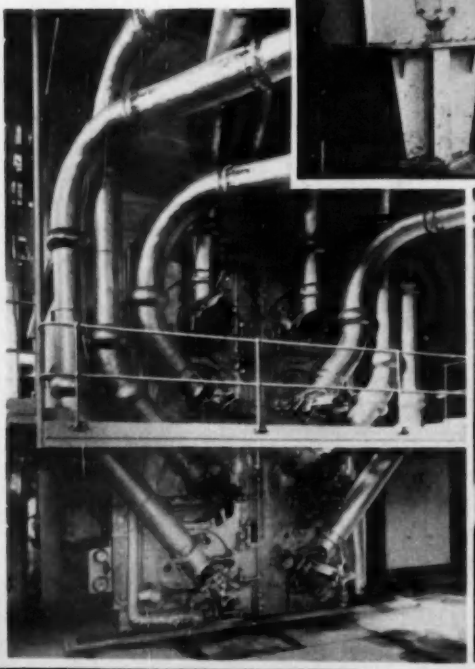
(Left). Close up view of one of the four Babcock & Wilcox rotary hoppers shown in the illustration above.

mixer, under overband magnetic separators to remove tramp iron, and is delivered overend from No. 1 conveyor to No. 2, a short reversible-belt conveyor which delivers it to the mixers, which in turn deliver it to No. 3 belt-conveyor.

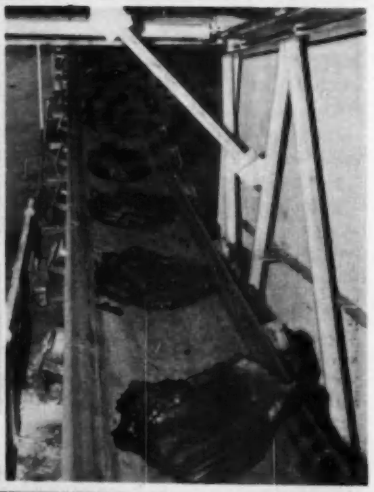
When mixing is not required, No. 2 belt conveyor is reversed so that the slurry is delivered overend direct to conveyor No. 3. This arrangement corresponds to the by-pass chutes and flap valves which would be used with normal coal, but would be completely useless with slurry.

(Right). The sixteen 9-ton capacity Babcock & Wilcox rotary slurry hoppers feeding the beater type mills in the boiler house

(Centre right). Slurry on belt conveyor on its way to the rotary hoppers in the boiler house.

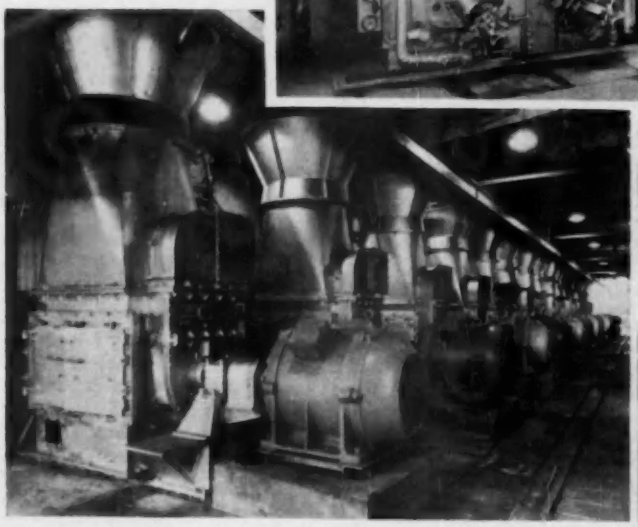


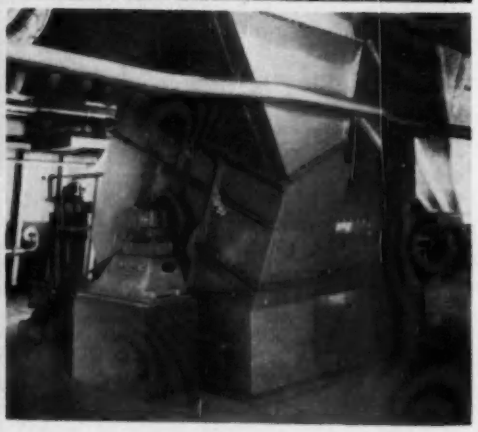
(Right). Front view of one of the four Babcock & Wilcox 150,000 lb./hr. boilers showing fuel pipes and oil lighting-up burners.



(Below, right). One of the 53,000 cu. ft./min. Howden F.D. fans.

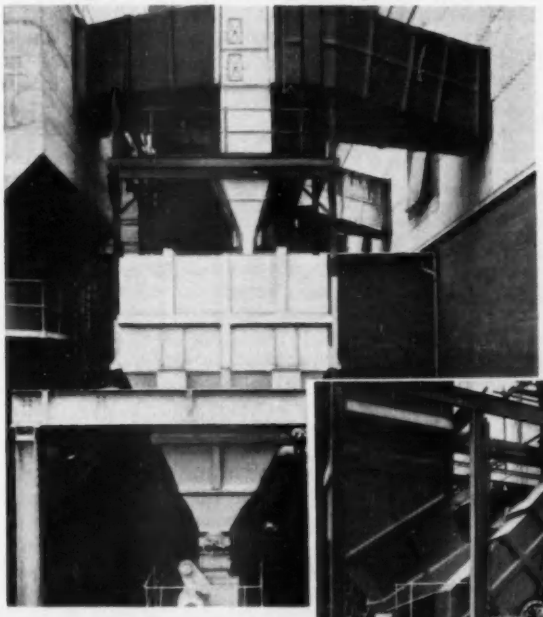
(Below). The sixteen Babcock & Wilcox 11,000 lb./hr. beater mills for slurry. There are four of these mills per boiler.





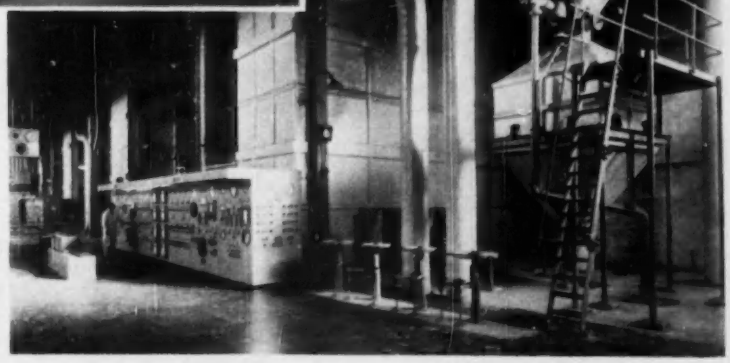
No. 3 conveyor rises to a junction tower where a right-angle bend is made in the approach to the boiler house. Here the slurry is delivered overend to No. 4 conveyor, down a short straight chute which is arranged with electrically-operated vibrating equipment to eliminate all possibility of a hang-up. The slurry is transferred by No. 4 conveyor to the boiler house, where it is transferred overend to a reversible shuttle conveyor (No. 5) which, being movable longitudinally, can deliver the slurry to any one of 16 hoppers. These are also of the rotary pattern, there are four to each boiler, and they are smaller editions of the main hoppers at the coal store. From these, the slurry is fed to the pulversing mills.

The 16 Babcock & Wilcox rotary hoppers in the boiler house are driven by electric motors of the squirrel-cage type with direct-on starters through 16 size 16.25 Vulcan-Sinclair fluid coupling units of the traction type, which were supplied by Fluidrive Engineering Co. Ltd.



(Above). One of the Howden Multi-Vortex dust-collectors and dust hoppers.

(Centre). One of the Howden 94,000 cu. ft./min. induced-draught fans serving each boiler.



(Right). Boiler house operating floor showing control panel for two of the four boilers; also showing (on right) are the hoppers for the Hydrovac dust-handling plant.

The slack coal, which as previously mentioned is located in a special section of the storage area, is primarily used for boiler starting-up purposes, although it is also available as an alternative fuel. Like the slurry-handling system the slack coal handling plant (also supplied by Babcock & Wilcox Ltd.) includes means of weighing the fuel passing, as well as magnetic equipment for the detection and retention of tramp iron. The slurry-handling system is designed to deliver 80 tons/hr., and the slack coal system 50 tons/hr., to the boiler house. Unlike the slurry plant, which runs continuously (the hoppers providing only buffer storage to absorb fluctuations in mill loading), the slack-coal handling plant can be shut down when the bunkers are filled.

Boiler plant

The four Babcock & Wilcox boilers are of the two-drum high-head type, designed for a maximum continuous evaporative capacity of 150,000 lb./hr., with a superheater outlet pressure of 625 lb./sq. in. and a final steam temperature of 865 deg. F. The guaranteed gross efficiency of these boilers is 79.5 per cent. when operating with fuel having an average calorific value of 6,450 B.Th.U./lb., and a feedwater temperature of 356 deg. F. The boilers are designed to operate satisfactorily with a fuel c.v. ranging between the limits of 5,500 to 8,000 B.Th.U./lb. The radiant type of furnace has front and side walls of spaced bare water-tubes, and rear walls of tangent bare water-tubes. Each furnace has eight pulverised-fuel-burners firing horizontally through the front wall, while eight retractable oil-burners equipped with automatic spark ignition are provided for lighting-up purposes.

The superheaters are of the pendant multi-loop type, having primary and secondary sections, with interstage surface-type attemperators and automatic temperature control guaranteed to maintain the designed superheat temperature within ± 15 deg. F. at all boiler loadings between 120,000 and 150,000 lb./hr. A large capacity air-heater supplied by Babcock & Wilcox Ltd., and of that firm's

cross-flow tubular type, with a total heating surface of 47,000 sq. ft. and comprising primary and secondary sections, with three air-passes, is provided for each boiler to supply hot air for combustion and for fuel drying in the p.f. mills. Four Babcock high-speed beater-type pulverising mills are provided for each boiler, each mill being designed for a throughput of 11,000 lb./hr. of slurry having a moisture content of 30 per cent., at a hardness of 75/80 Hardgrove. The mills have water-cooled shafts which allow a very hot gas/air mixture to be used, to allow for rapid drying of the fuel during pulverising.

At the designed rating of the mill, approximately 4,800 lb. of hot gas/air mixture at 1,180 deg. F. is required to reduce the moisture content of the fuel to 1 per cent. Fuel is fed to the mills by chutes from the 16 rotary hoppers or from the slack coal bunkers, and discharged in the usual manner to the boiler burners. Before leaving the mill, the pulverised fuel passes through an integral classifier which is fitted with adjustable flap dampers. The classifier returns to the mill for regrinding, any fuel particle above a certain size. A damper system, automatically controlled, adjusts the temperature of the hot gas/air mixture entering the mill to that required to reduce the moisture to 1 per cent. Each p.f. mill is driven by a 135 b.h.p. 975 r.p.m. G.E.C. induction motor, while the mill exhauster fans, which were supplied by Sturtevant Engineering Co. Ltd., are driven by 55 b.h.p., 1,460 r.p.m. induction motors also of G.E.C. manufacture.

The design of the air-heaters and of the economisers (the latter being of the Babcock multi-loop type, arranged in one bank), has been adjusted so that the heat loss at the boiler exit is not excessive when slack-coal or a mixture of slack and slurry is being burnt. The boiler efficiency is thus improved when burning the mixture, at the expense of some loss of efficiency when burning slurry, which requires a considerable quantity of hot air for drying. All four boilers are interconnected through two steam-receivers so that any individual boiler can operate with either of the two turbo-alternator sets.

The draught plant for each boiler comprises one 52,000 cu. ft./min. F.D., and one 94,000 cu. ft./min. I.D. fan—all fans being equipped with vane control and supplied by James Howden & Co. Ltd. The F.D. fans are driven at 970 r.p.m. by G.E.C. 104 h.p. induction motors, and the I.D. units at the same speed by G.E.C. 203 h.p. induction motors. A single Sturtevant electrostatic precipitator preceded by a Howden multi-vortex dust-collector having an integral secondary collector of the 3V " Centicell " type. The mechanical collector is complete with large-capacity dust-storage hopper for intermittent dust disposal. There is a total of 44 dust-separating cells per boiler.

The soot-blowing equipment supplied by Babcock & Wilcox Ltd. comprises two electrically-operated mass-jet blowers for the tubes of each boiler and two rack-blowers and two mass-jet blowers for the superheaters.

Boiler control equipment

An automatic system of boiler control, supplied by Electroflo Meters Co. Ltd. is installed, and this has two main functions. The first is to provide combustion control throughout a wide range of boiler loadings and with varying types of fuel, while the second is to ensure optimum conditions in the milling circuit, particularly when slurry and filter cake with a high moisture content is being burnt. For efficient control of combustion conditions, the pressure in the combustion chamber is measured and maintained at the requisite value by variation of the positions of the I.D. fan outlet vanes through a heavy duty furnace pressure to within $\pm$ 0.03 in. w.g. which is necessary for the control of the air flow to the p.f. burners at the optimum efficiency level. The actual flow of combustion air is measured by means of a Venturi section in the F.D. fan suction duct and controlled by varying the position of the F.D. fan outlet vanes through a regulator which continuously balances the Venturi differential against an air loading pressure derived from one of three sources. The source of loading to be used may be selected on the boiler control panel and a simple change-over valve allows control of combustion air either by hand setting (manual loader) or in direct ratio to steam flow (steam flow/air flow correction) or in such a manner that the oxygen content of the waste gases is automatically maintained at any desired level (oxygen correction). As regards control of the milling system, the equipment comprises a total of five regulators for each mill in order to provide a controlled volume of sweeping (or drying) air or air/gas mixture to allow for the final p.f./air mixture at the mill outlet to be maintained at a constant temperature of 210 deg. F. Continuous adjustment of the mill inlet temperature is made to produce a final temperature (p.f. and air) at a predetermined level set by the control of a model 196 Electroflo potentiometer. Hot and cold tempering air dampers are adjusted sequentially by the potentiometer impulse to maintain a steady outlet temperature of 210 deg. F. ; and to assist in this, electrical limits on the cold air damper regulator determine whether the mill is fed with hot waste gases at a temperature in excess of 1,000 deg. F. or with hot air from the wind box via the plenum pressure controller. The former is necessary when burning slurry, or fuel with a high moisture content, while the latter arrangement (hot gas damper shut) provides a lower mill inlet temperature under starting-up conditions when burning dry fuel.

With the exception of the mill outlet potentiometer, all equipment is air-operated by power cylinders of 3-in. or 5-in. bore supplied with air at a pressure of 30-40 lb./sq. in. All dampers can be manually-operated at the regulator themselves through a by-pass arrangement. An immediate change-over from manual to automatic operation, or vice versa, can be made on any unit from the panel within a few seconds.

Ash and dust-handling plant

The ash content of slurry is approximately 35 per cent. —the amount of ash to be handled per day at Barony being equal to about three times the normal amount to be handled from a conventional boiler plant of similar size. The ash is handled by the Babcock & Wilcox " Hydrojet " high-velocity sluicing system, having a capacity of 100-tons/day. Ash collected in water-filled hoppers under each boiler is discharged intermittently via high-velocity sluiceways to one of two underground bunker-type pits. The sluicing water overflows to a drain sump leaving the ash in the pit from which, after draining, it is grabbed to rail wagons by a B. & W. 7-ton overhead travelling grabbing crane. A draining apron is provided

for further drainage if required. Hydroseal return water pumps in the drain sump pump the water to a reservoir, where Hydroseal high-pressure pumps are installed to provide the sluicing and deliver the Hydrovactor water.

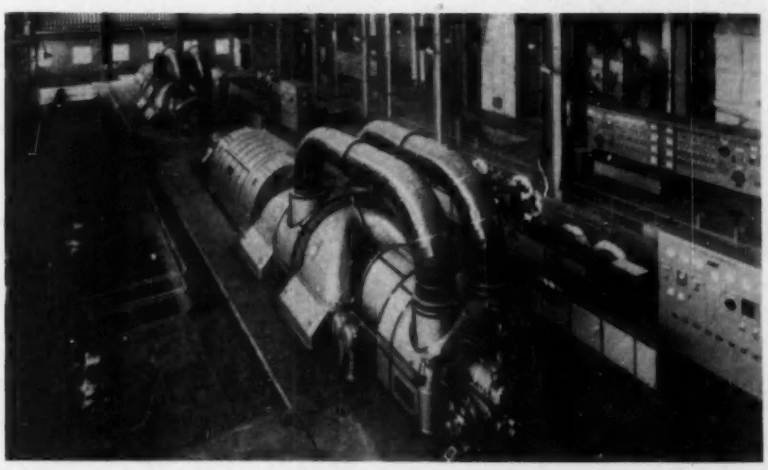
The Hydrovac dust-handling plant has a capacity of 300-tons/day. Windswept dust valves attached to each of the electrostatic precipitator, economiser, air-heater and chimney hoppers are intermittently operated to feed dust into suction piping through which it is carried to two M.S. Cyclone storage tanks. The vacuum is produced by two Hydrovactors mounted above the reservoir. Mixer-conveyors are provided at each cyclone outlet to discharge conditioned dust into railway wagons. The dust from the mechanical collectors is discharged direct into twin mixer-conveyors arranged to feed via a belt conveyor to wagons.

Water treatment plant

This plant, supplied by The Permutit Co. Ltd., has been designed to provide treated water up to 1,100 gal./hr. of water for boiler feed which is substantially free from dissolved solids, and with an electrical conductivity of one reciprocal megohm/cm.^{3} or less. Raw water from the County of Ayr supply is treated with alum by means of a pressure-operated Permutit alum doser and the coagulated suspended matter is removed by passage through a 4-ft. dia. pressure sand filter. The suspended matter accumulating on the surface of the filter bed is removed from time to time by reverse flow washing, this operation being preceded by air scouring, to loosen the filter medium. Air for this purpose is provided by a self contained rotary blower. The clarified filtered water is passed to two Permutit mixed-bed "Deminrolit" units, to remove dissolved solids. These units contain a bed of intimately mixed anion and cation exchange materials. Mineral salts in the water are converted to their corresponding acids by the cation exchange material and these acids are simultaneously absorbed by anion exchange. When the exchange capacities of the ion exchange materials have become exhausted, they are regenerated, the cation exchange material with dilute sulphuric acid and the anion exchange material with dilute caustic soda solution. Full facilities are provided for the preparation and dilution of these chemicals, acid handling being by the Permutit Vacuumatic System, which avoids manual contact with acid. The quality of the treated water leaving each of the mixed bed units is monitored by two type D.T.3 conductivity testers, which are fitted with alarm circuits.

Turbo-alternator plant

The two 30-MW 3,000 r.p.m. turbo-alternators were supplied by The General Electric Co. Ltd. They are of conventional design, and operate with stop valve steam conditions of 600 lb./sq. in., at 850 deg. F., and a vacuum of 28.7-in. Hg., when the circulating-water temperature is 70 deg. F. Each turbine exhausts into condensers of twin-shell construction, and four stages of bled steam feed-heating are provided to give a final feed temperature of 356 deg. F. All the condensing and feed-heating plant was designed and supplied by Hick, Hargreaves & Co. Ltd. Each twin-shell main condenser has a total cooling surface of 30,000 sq. ft., and is arranged for two passes on the cooling water side, the designed cooling water quantity being 23,000 g.p.m. Two 100 per cent. duty "Hivac" single-stage extraction pumps are associated with each main condenser, either pump being capable of discharging all the condensate and returned drains through the low-pressure feed system. The four-stage feed-heating system comprises one l.p. surface type heater, a gland heater and three high-pressure heaters. For the purpose of deaerating all incoming make-up, a standard Hick, Hargreaves' 40,000 lb./hr. shunt deaerator is connected across a 3,000 gal. capacity vessel in the surge tank leg. This system ensures that no undeaerated make-up water enters the system during on-load conditions, and, in addition, is capable of being operated independently when the main plant is closed down, which ensures that the system is oxygen free prior to starting up. The three high-pressure feed heaters are arranged for two "U" passes on the feed side.



Turbine room showing the two 30-MW generating sets which were supplied by the General Electric Co. Ltd.

Under design conditions the three heaters are capable of raising the temperature of the feed water from 187 deg. F. to the specified final feed temperature of 356 deg. F. There are three main motor-driven circulating-water pumps, each capable of delivering 25,000 gal./min. from the main condensers to the cooling towers. These pumps were supplied by Drysdale & Co. Ltd. The cooling water is pumped from the River Lugar through a pipeline one mile long, against a total head of 250 ft. To ensure adequate supplies of cooling water during periods of low flow in the river, a reservoir with a capacity of 6 million gal. is constructed at the base of the cooling towers.

Three motor-driven and two steam turbine-driven boiler feed pumps are provided. The former which were supplied by The Harland Engineering Co. Ltd., are 7-stage "Spiroglide" pumps of the "through-bolt"

construction, each pump having a capacity of 330,000 lb./hr. (570 g.p.m.). The discharge pressure is 815 lb./sq. in., and pump speed 2,970 r.p.m. Each pump is driven by a totally-enclosed Harland, water-cooled, squirrel-cage motor rated at 480 b.h.p., 3,300-V, 3-phase, 50 c/s and arranged for direct-on starting. The two turbine-driven pumps were made by G. & J. Weir Ltd., and they are fitted with non-return discharge valves fitted with Weir relay-operated automatic by-pass and automatic cut-in-gear. Each pump has an output of 330,000 lb./hr. at a discharge-pressure of 815 lb./sq. in. Steam supply to the turbine is at 600 lb./sq. in., and 850 deg. F.

The whole project was engineered by the South of Scotland Electricity Board's chief engineer and his staff, while James Williamson & Partners, Consulting Engineers, were responsible for the civil engineering work.

Giant Boiler for 550-MW Generating Set

THE Central Electricity Generating Board have issued brief particulars of a 3,750,000 lb./hr. boiler which they propose to order from International Combustion Ltd., to supply steam to a 550-MW turbo-alternator set. So far as is known, this boiler is the largest single unit under project in the world. The 550-MW generating set will also be very much larger than any now in operation, and will have an output greater than the total output from any one of the Board's existing power stations. The generating capacity of the machine will exceed that of the whole of the generating plant installed at Battersea power station, London, and only at Barking (London) and at Hams Hall (Birmingham), where in each case there are three individual stations, is there a larger aggregate capacity of generating plant installed on one site.

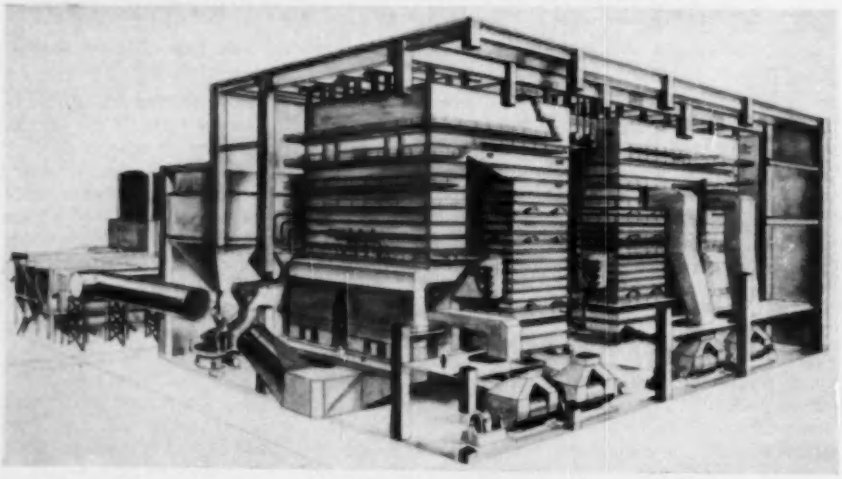
The decision to build unit plants of this large capacity is the latest step in a development programme aimed at effecting economies in the cost of generation by increasing the size and efficiency of boilers and turbo-alternators.

This very large boiler and its associated generating set is projected for installation in the power station which it is proposed to construct at Thorpe Marsh, near Doncaster. Application has been made by the Central Electricity Generating Board for the consent of the Minister of Power to the establishment of a 1,100-MW station on this site.

A station of this size, which will cost approximately £40 million, will require more than 2½ million tons of coal a year. This will be drawn from a wide area covering the Yorkshire coal field, and the northern parts of the Nottinghamshire coal field. The quality of the coal will vary over a wide range, with ash content varying from 6 to 30 per cent. and moisture from 4 to 20 per cent. Special steps have been taken in the design of the boiler to enable this range of characteristics to be accepted. It is estimated that the hourly coal consumption of this very large boiler will be between 205 and 220 tons, depending, of course, upon the coal quality.

The boiler is designed for a continuous maximum rating of 3,750,000 lb./hr. at a pressure of 2,400 lb./sq. in. and a final temperature of 1,055 deg. F., with reheat of the steam to 1,055 deg. F. after it has passed through the high-pressure section of the turbine. The feed-water will enter the boiler at a pressure of approximately 2,600 lb./sq. in., and at a temperature of 496 deg. F. at full load conditions. The boiler will have twin furnaces, each 68-ft. wide by 28-ft. deep by 100-ft. high, sub-divided into two sections, and fully-cooled by walls of water tube or steam tube construction. One furnace will control the main steam temperature, and the other the reheat steam temperature. The centre line of the main steam and water drums of the unit will be 148-ft. 6-in. above ground level. Careful design has been required to limit this height, as in a unit boiler serving a 200-MW set the centre line of the drum is at a height of about 135-ft., and there is a natural tendency for height to increase with size.

Assisted circulation will be employed ; all the water-tubes in the furnace and elsewhere being fed at regulated



Isometric view giving an indication of the appearance of the 3,750,000 lb./hr. boiler, to be designed and constructed by International Combustion Limited, for supplying steam to the turbine of a 550-MW generating set.

rates by glandless pumps of a special type, and of 6,000 gal./min. capacity with the motors driving the pumps water-immersed to avoid the necessity of bringing out the moving shafts through the pressure casings.

Pulverised fuel will pass through burners in the corners of each furnace, from which the flames will be directed to form a vortex in the centre. There are to be eight International Combustion "Lopulco" pulverising mills—four to each furnace, and of such capacity that three will be adequate to sustain full boiler load—leaving the fourth as a standby unit, thus allowing any of the other mills to be free to be taken out of service for maintenance. Each of these mills will have a nominal maximum capacity of 50 tons/hr.

The boiler will be equipped with two economisers, four rotary air-heaters and four sets of fans (four F.D. and four I.D.) per unit. The most up-to-date design of mechanical and electrostatic dust-cleaning plant will be installed to clean the flue outlet gases, the cost of which plant will represent something in excess of 10 per cent. of the cost of the boiler plant as a whole. The boiler, which will have a guaranteed efficiency of 90 per cent., will have an evaporative capacity nearly three times that of any single unit under construction in this country today, viz., the 1,400,000 lb./hr. unit boilers also being constructed by International Combustion Ltd., for the C.E.G.B. High Marnhan power station, for servicing 200-MW sets, and more than four-and-a-half times the capacity of the next largest boilers—the 830,000 lb./hr. units, again being constructed by International Combustion Ltd. to serve the 100-MW sets at Willington "A" power station.

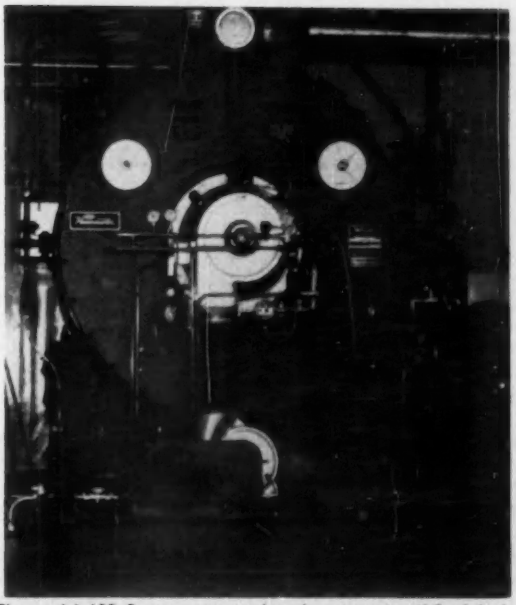
A Press conference, presided over by Sir James Reid Young (chairman, International Combustion Holdings), to "announce" the new boiler was held on February 12th. At the conference some interesting design details of the boiler were given by Mr. John Mayer (joint managing director, International Combustion Holdings Ltd.). Mr. Mayer said in the design there had been the closest co-operation between the design department of his own company and the headquarters technical staff of the Central Electricity Generating Board.

By comparison with a 515,000 lb./hr. boiler unit, the largest only a few years ago, and designed to serve a 60-MW generating set, the new 3,750,000 lb./hr. unit will occupy about half the combined space that would be necessary for the boilers serving a series of 60-MW sets with a comparable aggregate capacity.

Furthermore, by incorporating the latest techniques in design, including assisted circulation, improved combustion chamber design, etc., the capital cost of the boiler will be approximately 65 per cent. of that which would be involved with the requisite number of 515,000 lb./hr. units to give an equivalent total output. Mr. Mayer said that the complete 550-MW boiler/turbine unit would be in commission by March, 1963.

COST SAVING BY NEW BOILER AT A LAUNDRY

As part of a general scheme of expansion, the Bourne Hygienic Laundry, Bourne, Lincs, which has an average throughput of 30,000 lb. of laundry each week, recently installed a model 100 Powermaster packaged automatic oil-fired boiler, supplied by G.W.B. Furnaces Ltd., Dudley, Worcs. Prior to this, steam was provided by a vertical coal-fired boiler which had been modified some years previously by the addition of an automatic stoker. The average steam load on the old vertical boiler was 1,900 lb./hr. at 75 lb./sq. in., and while this load has not yet been increased, the working pressure has now been raised to 100 lb./sq. in. with the result that plant efficiency has been increased and higher operating speeds are obtained. Peak loads of 2,400 lb./hr. can now be catered for. The model 100 Powermaster is capable of a maximum output of 3,450 lb./hr., and has a guaranteed efficiency of over 80 per cent. In actual fact, during the final firing test at the manufacturers' works the calculated efficiencies on high- and low-fire were 83.25 and 85.5 per cent. respectively. These efficiencies were calculated from stack temperatures of 498 deg. F. on high-fire and 396 deg. F. on low-fire, with an accompanying flue gas CO_2 content of 13 per cent. in each case. Peak loads present no difficulties due to the automatic operation of the boiler which adjusts steam output in accordance with demand and, in so doing, modulates the firing rate over 30 to 100 per cent. of the firing range. Over this modulating range the correct fuel/air ratios are constantly maintained to give the most efficient operation. The choice of a Powermaster boiler also enabled building costs to be reduced, since the floor space occupied by these units is up to 50 per cent. less than that required by a conventional boiler of equivalent capacity. The new boiler is fired with 950 sec. fuel oil and the present consumption is on an average, 700 gal./week at a cost of 10¼d./gal., and the immediate results have been ascertained as a total saving of over 18 per cent. inclusive of fuel and direct labour. The boiler is used for a period of 11 hours each day during a 5½-day week. The unit is switched-off at night and re-started at 6.45 in the mornings, and at 6.30 on Monday morning after the weekend shutdown. A 2,000-gal. oil storage tank is provided adjacent to the boiler house, the oil being heated by means of a steam/electric outflow heater to 100 deg. F., before it passes through a pre-heater fixed to the boiler itself prior to entering the Voriflow patented medium-pressure air-atomising burner. The amount of condensate return to the boiler averages between 50 and 55 per cent., and since the local water is hard, treatment of the boiler feedwater is necessary. The I.C.I. Ltd. "Alfloc" system is used, the additive being introduced to the boiler three times a day with a 30-gal. blowdown on each occasion.



The model 100 Powermaster packaged, automatic oil-fired boiler supplied by G.W.B. Furnaces Ltd., to the Bourne Hygienic Laundry. This particular unit is capable of a maximum output of 3,450lb./hr., with a guaranteed efficiency of 80 per cent.

Electro-Hydraulic Damper Controls

THE Lockheed electro-hydraulic damper control equipment employed on the Clarke, Chapman boiler plant installation at Goldington power station of the Central Electricity Generating Board is of particular interest, not so much because it constitutes a new development in the electro-hydraulic control technique, but because it forms an excellent example of the versatility of this method of control. Quite apart from any other considerations, the type of control panel employed at this particular power station is, in itself, of novel conception, and it is interesting to appreciate the various ways in which electro-hydraulic control has been applied.

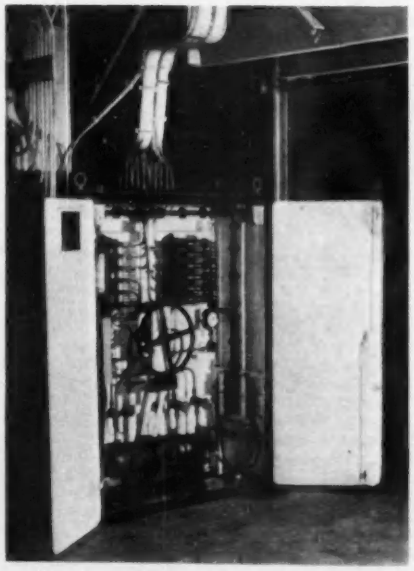
Control room

The equipment at Goldington affords " press-button " control from an unusual but well-designed " diagrammatic " control room, and it is in this important feature that the installation differs, noticeably—though not fundamentally—from the electro-hydraulic control equipment supplied for Brimsdown " B " and Rogerstone, the two power stations which share with Goldington the distinction of being among the first British generating stations to employ this new form of hydraulic damper control. The control panels, which form three walls of the control room at Goldington, are, in effect, " mimic boiler diagrams," and it is from these diagrammatic panels that the Lockheed equipment provides press-button control of the dampers served. It is these panels, and associated equipment provided especially for them, that make the Goldington control equipment installation unusual. Even the widely-used and familiar " edgewise " type of damper " position-indicator " is conspicuous by its absence, for the indicators are of special form in which the usual pointer moving over a divided scale is replaced by a coloured bar which rotates through an angle of 90° in its diagrammatic duct. Immediately below each of these special indicators are the two push-buttons controlling an individual damper—one to give an opening and the other a closing movement.

As in other examples of electro-hydraulic controls, the cabinet housing the main hydraulic and electro-hydraulic units is located in a convenient position near the boiler unit served, and the only connection between this cabinet and the control panel is by multi-core cable, while a pair of small dia. copper pipes are run from the cabinet to each damper-operating cylinder. It is thus no extravagant claim to say that this form of electro-hydraulic control uses both the electrical and the hydraulic portions of its make-up ideally, since all wiring, switches and contacts are employed in locations where they are not subjected to the influence of heat and dust, while the hydraulic units are used for damper actuation, for which task their inherent virtues and superiority over other methods cannot be denied. Another important advantage of the electro-hydraulic method of damper operation is that since the only connection between control room and hydraulic cabinet is by means of multi-core cable, the distance from the control room to the boiler served need no longer be a disturbing factor. Therefore, a distant control does not necessitate long pipe runs, and the consequent resulting excessive pressure-drop.

Power and control cabinet

The power and control cabinet houses the motor-pump unit, which provides the necessary operating fluid pressure, together with its contactor-starter, and the relay unit which acts as pilot switch for this. The electrically-operated selector valves, one for each damper served, are also mounted within the cabinet, together with the usual switch-fuse unit and other ancillaries. Provision is made for regulating the speed of movement of each damper independently, an adjustable two-way restrictor valve being fitted in the line leading to the " full-area " end of each damper-actuating cylinder. The speed of movement can thus be set for each damper, independently for each direction of movement, in accordance with requirements, and so that the operation of



The Lockheed power cabinet at Goldington power station. The handwheel is for emergency operation in the event of complete power failure.

" regulating " dampers will afford the desired accuracy of control. From the operator's point of view, the controls at Goldington render damper operation both simple and effortless. To operate a damper, it is only necessary to press the appropriate push-button, watch the adjacent indicator, and release the push-button just as the damper is about to reach the desired angular position as shown by the indicator. The moving bar of the indicator is in line with its diagrammatic duct when the damper is fully open, at 45° when it is half open and at 90° when the damper is closed.

Emergency power control

In the event of failure of the 110-V control circuit supply, or of any unit of the electrical control portion of the equipment, power-hydraulic operation of the dampers is still available, but it now becomes necessary to actuate the selector valves (normally solenoid-operated) by hand, in the control cabinet, and an instruction plate is provided, giving the necessary information. All that is necessary is to move the hand lever of the appropriate selector valve in the direction which will give the required damper movement and then run the motor-pump unit by pressing the " start " button of the contactor-starter. Further, in the event of a power failure or trouble with the motor-pump unit, dampers can still be selected for operation by manual actuation of the valves as mentioned above, but it then becomes necessary to use the emergency hand-pump to provide the necessary operating fluid pressure. The cabinet is provided with interior lighting which is automatically " switched on " when the door is opened.

Hydraulic centralised controls, both manual-hydraulic and power-hydraulic, have already, from time to time, received some attention in the pages of this journal, and their use for damper operation, window control, and for other applications at generating stations has been described.

It may be of interest to give, at this stage of these notes, a brief résumé of past developments, regarding Lockheed damper control equipment, in order to outline the trends that have led to the use of the electro-hydraulic method, and, finally, to appreciate the versatility of this form of control, together with new features which its use has made possible.

The principal component of the earliest " oil-hydraulic " remote control system, as produced by the Lockheed Company nearly twenty years ago, and soon appreciated by leading boiler plant manufacturers and operators, was the " transmitter " or duo-directional pump. This handwheel-operated unit, in which reverse rotation of the handwheel gave reversal of fluid flow, made possible the operation of a remote cylinder, connected to the fluid supply by two small diameter pipes, to give either direction of piston movement as desired. The subsequent addition of selector valves enabled a single transmitter unit to operate, one at a time, a number of cylinders ; indication units, hydraulic in some cases, electric in others, were subsequently added to enable an operator to follow movement imparted to cylinders located beyond his range of vision. The manual-hydraulic system proved to be entirely successful, and is still functioning in many small power stations and industrial boiler plants, and, indeed, is still ordered for such. Where, however, the increased size of boiler units warrants it the employment of a power-hydraulic system becomes desirable.

Power operation

The increasing size of boiler units installed in power stations, together with the additional number of dampers, made power operation desirable if operator fatigue was to be avoided. Thus the motor-driven pump—used in conjunction with a " metering and reversing valve " to give the required reversal of fluid flow—was added. It was added, rather than substituted for the hand-operated unit, as the latter was retained as part of the control system in most cases, to serve as an immediately-available stand-by pressure source. The auto change-over valve—a unit unique to hydraulic systems—made it possible for either pressure source to bring itself automatically into circuit as soon as it created fluid pressure. This valve unit also made possible the use of local control points and alternative pressure sources.

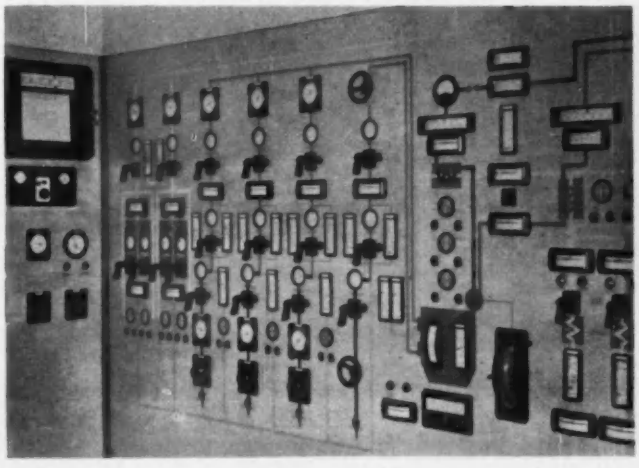
An outstanding advantage, common to all Lockheed centralised control systems of this type, was that no part of the system was subjected to fluid pressure except at actual moments of operation. This was made possible by the Lockheed " Autoloc " cylinder, which incorporated a mechanical locking device in its piston assembly. This mechanical lock could be released by fluid pressure only, and the piston would remain locked at a desired stroke position until fluid pressure was applied to cause a change in stroke position, thus the whole system was vented to atmosphere during actual operation of the damper.

Over-riding controls

Centralised hydraulic controls of this type soon came to be accepted as the standard method of operation for all dampers except those under " automatic " control, and even these automatically actuated dampers, ordinarily operated by pneumatic means, were frequently provided with hydraulic over-riding controls which could be brought into use in any case of failure of the air-pressure supply or other possible trouble, thus eliminating the dangerous possibility of such dampers " drifting " uncontrolled.

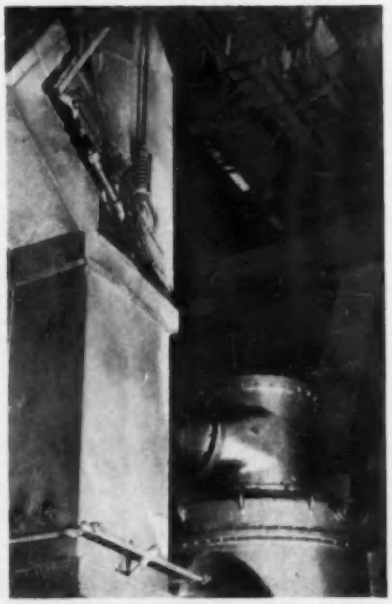
Other developments

The success of the hydraulic method of control, and the fuller appreciation of some of the inherent advantages of hydraulics, soon led to their use for numerous other applications at power stations, and hydraulically-operated automatic soot-blowers, produced in collaboration with Babcock and Wilcox Limited, were soon in service on numerous boiler plant installations. Hydraulics were also introduced into service for window control, and for various

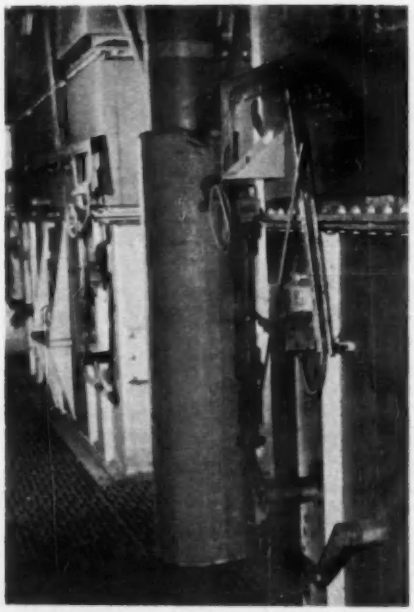


Part of a wall in one of the plant control rooms at Goldington. The mimic diagram which shows the position of the Lockheed damper controls can be seen to the right of the illustration.

duties in connection with ash and dust-handling plant. It is highly probable, in fact, that one of the first applications of the electro-hydraulic method was in the performance of operational sequences in connection with dust-handling, the vacuum transfer valves and internal and external " dump gates " of dust-collecting cyclones being operated in sequence, as required, to transfer accumulated dust from the upper to the lower chamber of each cyclone in succession, and, in sequence, to dump it from the lower chamber on to a conveyor belt or into hoppers or to some other means employed for its removal. Electro-hydraulic controls of this type usually operate by means of a camshaft, which actuates switches as required to energise and de-energise the electro-magnetic thrustors employed to give plunger movement in the hydraulic control valves governing the operation of the valve-operating and gate-operating hydraulic cylinders.



(Left). One of the Lockheed hydraulic cylinders controlling the flow of warm air to one of the 300,000 lb./hr. Clarke, Chapman boilers at Goldington power station.



(Right). A battery of three Lockheed " Autoloc " slave cylinders for operating dampers on the boiler plant at Goldington power station.

At about the same time as these developments were finding new spheres of usefulness for hydraulic and electro-hydraulic control, two new tendencies became noticeable in the general layout of plant in generating stations. An increasing necessity for the operation of boilers from " control rooms " situated some distance from the boilers served became evident, and, at much the same time, automatic closing of certain dampers came to be regarded as an essential safety measure, the closing of i.d. and f.d. fan dampers in the event of fan motor stoppage being a good example, since automatic closing would eliminate the danger of a " blow-back " of hot gases.

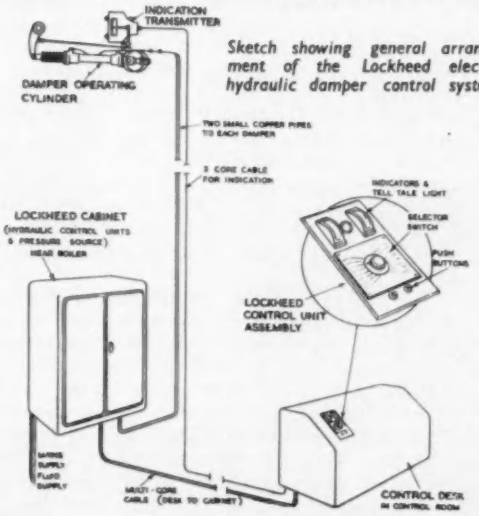
It was these two factors, remote control rooms and automatic closing of certain dampers, that made the use of the electro-hydraulic method essential for boiler damper control. A small, compact control unit assembly was specially designed to occupy a minimum of space on the " desk type " control panel which is now almost standard. With a height of little more than 16-in. and a width of 8-in. or so, this assembly is a small, well-finished insert panel on which are mounted the selecting, controlling and indicating units designed to serve as many as twenty dampers.

The centre portion of this panel is occupied by the selector switch, rotation of which selects the desired damper, which it brings " in circuit " both for operation and indication. Above the selector switch are mounted the indication units and the tell-tale light, while below it are fitted the " open " and " close " push buttons, or, alternatively, any form of " two position and off " single-pole switch, a switch of the " pistol grip " type being used in many instances. On these " panel " units, the " selector " is a 20-position rotary switch with the necessary " operation " and " indication " contacts for each position, the indication units above it being a " limit indication " light unit, an edgewise regulating indicator or both, while the " tell-tale " light, which merely informs the operator that the electrical portion of the controls is in working order, can be regarded as optional. As an alternative to their incorporation in this control unit assembly, as described above, these electrical control-instigating units can be mounted in locations as desired on the desk type or other form of control panel face itself.

A new and additional refinement—optional, as in the case of the tell-tale light—is a switch, of the push-button or other type, to afford, in effect, two-speed damper operation. As has already been explained, in the description of the Goldington installation, a two-way restrictor valve can be employed to govern speed of operation for each damper and, as an alternative, speed of movement of all damper-actuating cylinders can be slowed as desired in the same way. This additional switch, then, is employed to give opening of a by-pass valve, thereby affording operation of any desired damper, at the maximum speed limited only by pump output.

Automatic closing of certain dampers has already been

mentioned as a desirable feature of damper control equipment and, in electro-hydraulic controls this is not only achieved in a simple manner by the use of an



Sketch showing general arrangement of the Lockheed electro-hydraulic damper control system.

additional pair of contacts on the fan motor contactor starter, which are employed to energise the appropriate coil of the relevant electrically-operated selector valve, but this circuit can be extended to include a thrustor-operated valve to render other controls inoperative until closing of the fan dampers has taken place. A further refinement can prevent the opening of the fan (or other) dampers until the fan motor is run up to adequate speed.

It can now be appreciated that the electro-hydraulic controls at Goldington power station, while following the general development pattern of these controls in general principle, differ by utilising their novel diagrammatic control panels, and the special forms of indicator units necessitated thereby. It might be mentioned that special indicators, of "miniature" dimensions, can be provided to cope with restricted control panel space, and that these are of the same well-known contactless form as the edgewise indicator units already so widely employed.

Certain units in the Lockheed electro-hydraulic control system, particularly those which are cardinal components in the successful operation of the system are the subject of patents taken out by the company.

In conclusion, it seems almost unnecessary to add that no other method of damper control can claim all the advantages enjoyed by electro-hydraulics ; all the advantages of hydraulic operation are retained, and the use and correct application of simple electrical switches make it possible to produce control units occupying the very minimum of panel space, and to permit the use of control points at any distance from the boilers served with none of the possible disadvantages previously inseparable from such conditions. It should be borne in mind that the only electrical units employed for control purposes are simple switches, and these are fitted only where they are not subjected to high temperatures.

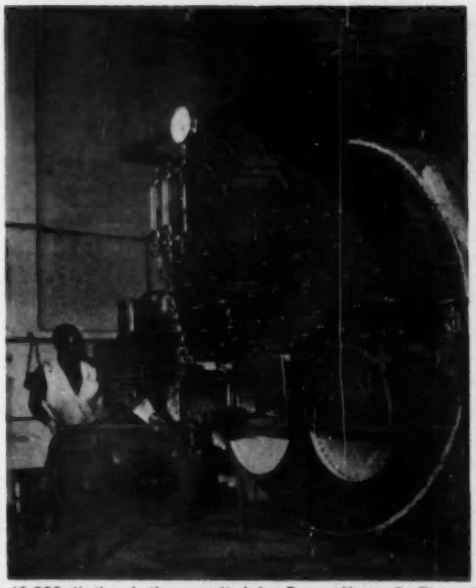
Boiler Plant for Nigerian Textile Factory

One result of the steady increase in cotton production in the Northern Region of Nigeria has been the construction of the new Kaduna textile factory formally opened on November 22nd, 1957, by H.R.H. the Princess Royal. The factory occupies a 52-acre site, and employs 700 Nigerians and 50 Europeans, and will, when in full production, produce some 12-million yards of cloth annually, all of which will be sold in Nigeria.

The boiler plant associated with the Kaduna factory was supplied by Foster Yates & Thom Ltd., Blackburn, Lancs, and comprises a single unit designed to supply 12,300 lb./hr. of steam at 150 lb./sq. in. and 212 deg. F., but at the present time operating at 120 lb./sq. in. It is 9-ft. 9-in. dia., 15-ft. 6-in. long over tube plates, and 20-ft. 6-in. long overall, and although eventually the unit will be fired by means of a "Proctor" mechanical stoker capable of burning local fuel, and operating with a 40-ft. high chimney above the smokebox and i.d. fan, hand-fired furnace equipment was provided, and this is being used at the present time. The i.d. fan is so arranged that the boiler can be warmed up on natural-draught and the fan brought into operation as required to provide full-duty. Two feed-pumps are provided, one steam-driven and one electrically-driven, each capable of supplying the existing boiler, and one of a similar capacity should this be installed at a future date. The boiler house is in fact arranged to accommodate such a unit. Feedwater is pumped from a nearby river to a feed-tank in the boiler house, while water storage in the form of a small reservoir has also been arranged to ensure an adequate supply during the dry season, when it is not possible to obtain water direct from the river.

Several operations in the manufacture of textiles require process steam, and to supply this a steam header with all necessary valves extends from the boiler house into the factory, from where it is taken, through reducing valves, if necessary, to the various departments.

The factory has been built, at a cost of over £1 million, for the Government of Northern Nigeria, in partnership with the British company, David Whitehead & Sons Ltd., who have been appointed managing agents. As with similar projects financial assistance has been given by the Northern Regional Marketing Board and the Northern Region Development Corporation, as one means of inducing more manufacturers to establish factories in Northern Nigeria.



The 12,300 lb./hr. boiler supplied by Foster Yates & Thom Ltd. for the new £1 million textile factory at Kaduna, Northern Nigeria, shown operating under hand-fired conditions.

Industrial Gas Turbo-Alternator Set

FOR many years, Richardsons Westgarth (Hartlepool) Limited, as the firm is now styled, have manufactured under licence from the well-known Swiss engineering firm of Brown Boveri of Baden, Switzerland, steam turbines, alternators, blowers and compressors.

Probably the best known of the recent turbo-alternator sets constructed by the company are the three 60-MW cross-compound machines installed in the Portobello (Edinburgh) power station of the South of Scotland Electricity Board, and the six 60-MW sets at Brighton "B," the five 30-MW sets at Acton "B" and the two 30-MW sets at Ocker Hill power stations respectively, of the Central Electricity Generating Board.

In 1954, the company, realising the success which Brown Boveri were attaining in the design and installation of gas turbines, and believing that there was a potential market in this country for gas turbine sets—particularly for service in steelworks—decided to take out a licence for the manufacture of gas turbines of Brown Boveri design. The first order to come within the new licence was obtained from Shelton Iron & Steel Limited for a power generating unit. This particular unit will be the first of its type to be installed in a steelworks in this country. By courtesy of Richardsons Westgarth (Hartlepool) Ltd. we recently had the opportunity of seeing this machine in operation on a specially-constructed test rig in the company's works at West Hartlepool.

It was originally specified that the machine at normal ambient conditions of 60 deg. F. and 14.7 lb./sq. in. should be capable of an output of 2,500-kW at the alternator terminals. We understand that the results obtained from the tests carried out so far make it evident that this output can easily be obtained at temperatures well below the maximum permissible at the turbine inlet, namely, 650 deg. F. The alternator and gearing are rated for a peak output of 3,200-kW, and additional power will be available without the maximum turbine inlet temperature being exceeded.

The Shelton gas turbine, which drives a standard alternator, is of the single-shaft open-cycle type, the operating cycle being shown in the accompanying diagram (page 86). The cycle is comparatively simple except for the use of heat-exchangers—two for the air, and a smaller one for blast-furnace gas when used as fuel. Air is drawn from atmosphere and compressed in a 14-stage axial compressor running at a speed of 5,350 r.p.m. and then passes to two heat-exchangers of identical size, in parallel. Each of the heat-exchangers comprises an outer shell (fabricated from mild-steel plate), and approximately 4,200 mild-steel tubes across which the air flows, at the same time picking up heat from the exhaust gases of the turbine, which are flowing through the tubes.

From the heat-exchangers the air is conveyed to a single combustion chamber which is of the vertical all-metallic type. Here, part of the air is used to burn the fuel admitted to the combustion chamber, and the excess air which is not necessary to maintain combustion is used to cool the combustion gases before they reach the gas turbine. The combustion chamber is located relatively near the turbine, to which the gases pass through a double-walled duct. This double-walled effect is continued in the inlet branch of the turbine right up to the first row of blades. The turbine is of the six-stage pure reaction type, and the combustion gases after expanding through the turbine pass, as previously mentioned, through the tubes of the heat-exchangers, to atmosphere.

Like the compressor casing, the turbine casing is split into two parts separated in the horizontal plane of the centre line of the shaft. In addition, however, there is a split in the vertical plane approximately in line with the last stage of blading. The entry portion to the turbine and the section carrying the cylinder blading comprises a casting of alloy ferritic steel. The exhaust section is, however, partly cast and partly fabricated, the fabricated portion being made up from molybdenum steel plates.

The turbine rotor, like that of the compressor, is constructed from three creep-resisting molybdenum vanadium steel forgings which are welded along the circumferential joints. Both the rotor and cylinder blades are made from high quality heat-resisting 17/13 stainless-steel material. The rotor blades have a serrated root and are inserted direct in corresponding grooves turned in the rotor. They are separated from one another by thin packing pieces. The cylinder blades like the compressor blades have a dove-tailed root. Cooling air is provided for the relatively hot portion of the cylinder, for the rib in the turbine entry branch, and also for the rotor end at the entry side, this air being taken from the discharge branch of the compressor.

When this machine is installed at the steelworks of the Shelton Company, the fuel normally employed will be blast-furnace gas. This fuel will be available at a pressure slightly above atmospheric, and as it has a low calorific value, it is necessary to employ a relatively large quantity of gas. For this reason a six-stage centrifugal-type compressor is employed to raise the pressure of the gas to a higher figure than the air pressure in the combustion chamber.

Gas compressor

The gas compressor is driven at a speed of 7,970 r.p.m. through speed-increasing gears from the main turbine and compressor shafts. A large proportion of the power produced by the turbine is absorbed by the air and gas compressors to which it is coupled. The excess power is available as net output at the terminals of the alternator which is driven through reduction gearing from the main turbine and compressor shafts.

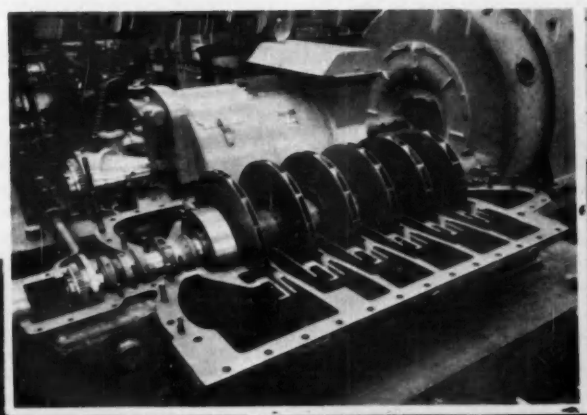
The compressor has six stages, and can deal with all the gas required for combustion at full load, together with a suitable margin. It is designed for a slightly higher pressure ratio than the main air-compressor. On similar gas turbine units which Brown Boveri have in operation in steelworks and which are designed to burn blast furnace gas, the compressor is of the axial-type.

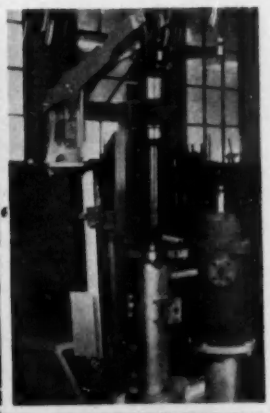
For the Shelton unit, however, no designs existed for an axial-type unit small enough to handle the gas volume required and it was decided to employ a centrifugal-type compressor.

Starting-up

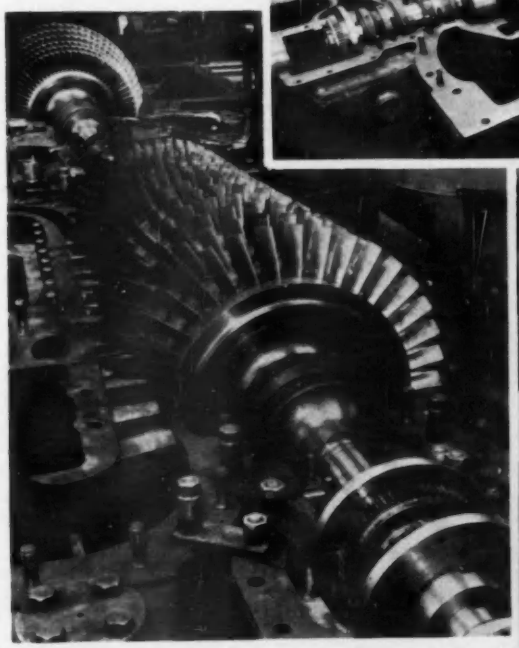
For starting-up purposes, an electric motor which can give an output of 142-kW at 1,000 r.p.m. is provided which can raise the speed to approximately one-third of the normal operating speed. This motor is not disconnected mechanically when the set is in operation but the brushes are lifted automatically when a self-sustaining speed is reached.

The output of the set at a given ambient air temperature and at constant speed is solely a function of the gas temperature at the turbine inlet. The output of the set is, therefore, controlled by varying the gas temperature, i.e. by regulating the fuel quantity admitted to the combustion chamber. It is the prime function of the governing system to control the fuel quantity in accord-





(Right). The blast furnace six-stage gas compressor rotor in cylinder, with starting motor and brush lifting gear in background.

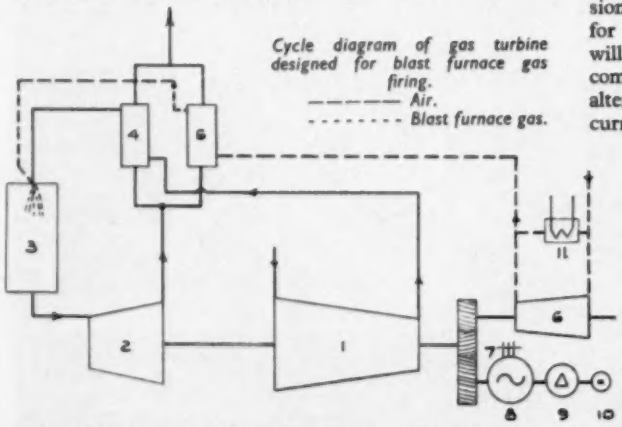


(Above). The fully-bladed air-compressor rotor in cylinder with gas turbine rotor in background.

(Top-right). Oil burner in retracted position, also ignition rod insertion gear in the retracted position, shown on combustion chamber cover.

(Bottom-right). A general view of the gas turbine on the test rig in the Hartlepool works of Richardsons Westgarth.

ance with load requirements at all times. To achieve this, the set is equipped with a speed governor of the spring-loaded centrifugal-type which is driven from the free end of the main driving wheel on the reduction gearing. This governor controls the pressure in the governing oil system and this pressure, in turn, controls the opening of the regulating organs by means of which fuel is admitted to the combustion chamber. The governing oil pressure is not only influenced by the speed governor but can at any time also be controlled manually by means of a starting valve which provides, in parallel with the speed governor, a drain opening for the governing oil. Although this set will normally operate on blast-furnace gas, a special feature is that it



KEY:—1, Air compressor. 2, Gas turbine. 3, Combustion chamber. 4, Heat exchange for air. 5, Heat exchange for blast-gas. 6, Blast furnace gas compressor. 7, Gear. 8, Generator. 9, Starting motor. 10, Exciter. 11, Blast furnace gas cooler.

can also operate on a mixture of blast-furnace gas and gas-oil and if essential on gas-oil alone.

In the event of a temporary shortage of blast-furnace gas, a separate gas-oil burner can be inserted in the combustion chamber simply by operating a magnetic valve. Automatic starting of the fuel-injection pump follows, and admission of gas-oil to the combustion chamber is initiated by a hand-operated valve. When operating on a mixture of blast-furnace gas and gas-oil, the quantities of fuel admitted to the combustion chamber are controlled by the hydraulic governing system. Alarms and trips are fitted to guard against high gas temperature at the turbine inlet, low-pressure in the blast-furnace gas main, loss of lubricating oil, overspeed of the units and other irregularities. To simplify the starting-up procedure the whole operation can be carried out from the control panel by means of programming switches. Under the operating conditions for which it is designed, the set is guaranteed to give an overall thermal efficiency of 20.5 per cent.

In addition to the machine for the Shelton Company, Richardsons Westgarth (Hartlepool) Limited have an order for two units for the Pakistan Industrial Development Corporation, and through British Brown Boveri, two units for The Kuwait Oil Company Limited. The two machines for installation in Pakistan are of the single-shaft open-cycle type without regenerators, and will be capable of an output of 5,700-kW at an ambient temperature of 40 deg. C. The alternators are rated for a maximum output of 7,000-kW at 0.77 p.f. These units are now in the course of construction and are due for delivery later this year.

The Kuwait units are also of the single-shaft open-cycle type without regenerators and are rated for an output of 7,500-kW at an ambient temperature of 50 deg. C. The order for these two units has only recently been secured and construction in the works has not yet commenced. All these units will operate normally with a natural gas fuel.

The Hartlepool company, in order to cope with the increased volume of business in the land turbine field, have in hand a development programme involving expenditure of approximately £1,750,000 for the extension of its manufacturing, erection and testing facilities for turbines and alternators. These extensions, which will be completed by the end of this year, will enable the company to manufacture and handle the largest turbo-alternator sets now envisaged. They form part of the current development programme of the Richardsons Westgarth Group.

Group activities

The comprehensive activities of the Richardsons Westgarth Group can be summed up very broadly as the manufacture of power generating plant for both land and marine installations—the plant comprising turbo-alternators, condensing and feed-heating plant, evaporating plant, turbo-blowers, gas-turbines, compressors, etc. In addition, the firm manufacture land and marine water-tube boilers and superheaters. A special feature of the Group's organisation is its ability to supply complete power plant installations for both central station and industrial requirements, including all auxiliary equipment.

A report has now been published on the **Second Specialist Conference on Fuel Research** which was held in London from July 9th to 16th, 1956. The conference was attended by delegates from official research organisations in the United Kingdom, Canada, Australia, New Zealand, South Africa, India, Rhodesia and Nyasaland and the Colonies. It was held under the chairmanship of Dr. A. Parker, C.B.E., formerly director of Fuel Research, and the conference discussed existing facilities for training in fuel technology and for carrying out fuel research in the Commonwealth, and the possibility of improving and augmenting these facilities. The possibilities of collaboration between the Commonwealth organisations in investigational work were discussed and arrangements made to initiate joint investigation in the fields of coke testing, coal grindability and petrographical work.

Yorkshire Imperial Metals Ltd.—the new company which represents the fusion of the copper and alloy tube, fittings and plate manufacturing activities of the **Yorkshire Copper Works Ltd.** and of **Imperial Chemical Industries Ltd.**—has now been formed. The new company disposes of assets worth about £18 million, including the former I.C.I. plants at Kirby (Liverpool), Smethwick (Staffs.), Landore (Swansea), and Dundee, and the former Yorkshire Copper plants at Leeds, Barrhead (Glasgow), and Castleford (Yorks.). The registered office of Yorkshire Imperial Metals Ltd. is at Haigh Park Road, Leeds. The board of directors has been constituted as follows:—From I.C.I. Ltd., Dr. James Taylor (chairman), Mr. Peter T. Menzies, Dr. Maurice Cook, Mr. Michael J. S. Clapham, Mr. St. John Elstub, Mr. Harold Royle, and Mr. Walter N. Ismay. From Yorkshire Copper Works Ltd.: Messrs. George P. Norton (deputy chairman), H. F. Sherbourne (managing), W. R. D. Macdonald, C. G. Robinson, Donald Fraser, J. Christie, Clifford Breckon. The company's secretary is Mr. P. D. Peel Yates.

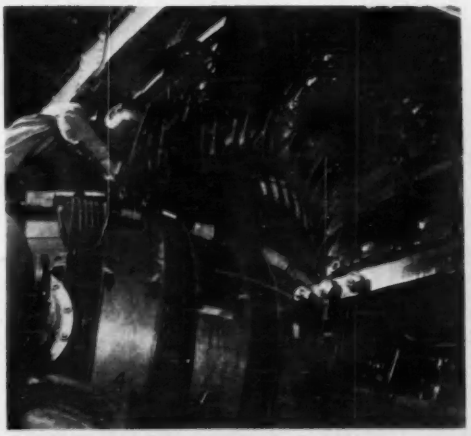
Progress in Thermonuclear Research

RESEARCH has been in progress for some years now to investigate the possibility of producing energy in a controlled manner from thermonuclear reactions. This work has been undertaken at the United Kingdom Atomic Energy Research Establishment, Harwell and the Research Establishment of Associated Electrical Industries Ltd., Aldermaston. Researches in this field have also been made in America by the U.S. Atomic Energy Commission, and on January 23rd, 1958, a joint Anglo-American statement was issued in order to publicise the progress made towards this end. At the same time representatives of the Press were invited to see the results of the work done in this country, namely the setting up of two independent, but closely related plants—ZETA (zero-energy thermal assembly) at Harwell, and SCEPTRE III at Aldermaston. ZETA was started up on August 12th, 1957, and on August 30th was first operated under conditions that produced nuclear reactions.

The reaction being studied in ZETA and SCEPTRE is that in which deuterons (nuclei of the heavy hydrogen isotope deuterium) collide with one another and fuse to form heavier nuclei, releasing energy and some neutrons in the process. Deuterium, although a rare isotope of hydrogen, occurs naturally ; a gallon of seawater contains about 1 gramme and it can be isolated relatively cheaply yielding very large quantities of energy (about 30 times as much as is needed to isolate it).

For fusion to be possible, the deuterons must have enough energy to overcome the initial electrical forces of repulsion between them. This necessitates heating the deuterium gas to temperatures of millions of degrees centigrade. At Harwell, temperatures as high as 5 million deg. C. have been reached, and the results obtained suggest that "thermonuclear neutrons" have been obtained ; but further experiments will be necessary before this can be proved conclusively. At Aldermaston, temperatures of 4 million deg. C. have been achieved, and here also neutrons have been observed.

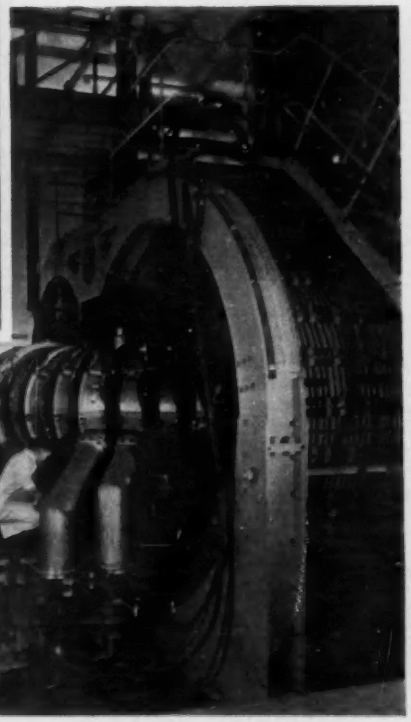
The hot gases must be kept away from the walls of the container in which the reaction takes place, in order to avoid losses in temperature. The principle adopted in ZETA to achieve these high temperatures under the correct conditions is to pass a heavy electrical current through the deuterium gas. This current sets up an electric discharge in the gas which heats it and also produces an intense magnetic field around the column of hot gas, which causes the discharge to become constricted and hence heated still more. Since it also causes an instability in the discharge known as "wriggling," the field by itself is not sufficient to



(Right). A close-up of the ZETA torus and transformer. The coils wound on the torus produce the stabilising field necessary to prevent the hot gas touching the torus wall.

(Extreme right). A general view of the plant. In the foreground can be seen the vacuum pumping system.

(Below). Part of the ZETA control room. Members of the group responsible for this research are shown making oscillographic measurements on the gas discharge within the torus.



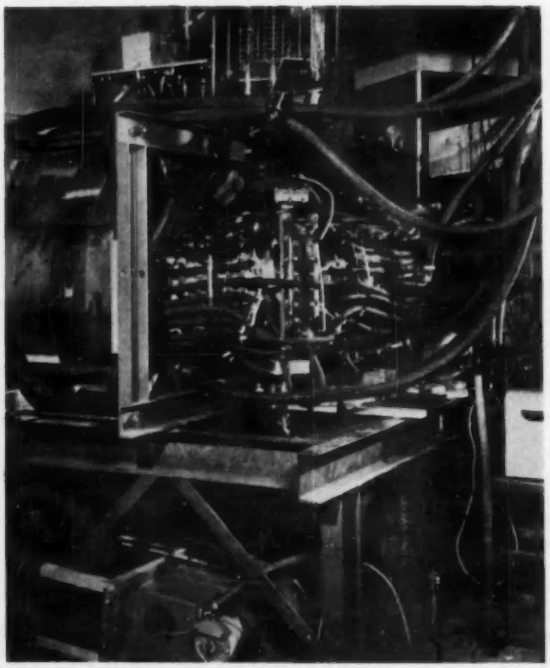
keep the discharge away from the walls, and an additional steady magnetic field parallel to the axis of the tube, has been applied to suppress this effect.

General views of ZETA are reproduced in the accompanying illustrations. The discharge chamber is a ring-shaped tube or torus of 1 m. bore and 3 m. mean diameter, made of aluminium and containing deuterium gas at low pressure. It contains an inner lining comprising a number of overlapping tubular sections, also manufactured of aluminium, encircircled by water-cooled tubes. For convenience of assembly the torus is divided into six sections, with flanged vacuum-tight joints. The torus is linked by the iron core of a large pulse transformer. The plant for energising the primary winding is installed in a separate area outside the 3-ft. concrete shield around ZETA itself. A current pulse of electricity is passed into the primary winding of the transformer from a bank of capacitors capable of storing 500,000 joules (or 14 kWh) of energy. This pulse in turn induces a very large unidirectional pulse of current in the gas, which forms a short-circuited secondary for the transformer. Peak currents up to 200,000-amp have been passed through the ionised gas for periods up to 5 milliseconds ; the current pulse being repeated every 10 seconds. Emission of neutrons throughout the current pulse is observed regularly in the routine operation of ZETA with deuterium, there being up to 3 million neutrons emitted per pulse.

Although the temperature of gas discharges may be determined from measurements on the light emitted by the gas atoms, the results are not entirely satisfactory, because at the temperature of the discharge in these experiments, the hot deuterium atoms are completely stripped of their electrons and therefore do not emit a line spectrum. A method of solving this problem is to mix with the deuterium a small quantity of some heavier gas, such as oxygen or nitrogen, the atoms of which are not stripped of all their electrons under these conditions, and to study the spectral lines emitted by this impurity ; the random motion of the high-energy impurity atoms which make many collisions with the deuterium atoms and so reach the same energy causes the spectral lines to broaden, owing to the Doppler effect, and the amount of broadening is a measure of the ion energy. Measurements by this method on ZETA have indicated temperatures in the region of 2 to 5 million deg. C. Whilst temperatures in this range are required to explain the observed rate of neutron production on the basis of a thermonuclear process, electric fields in the gas arising from instabilities, can also accelerate deuterium ions and lead to nuclear reactions. Therefore, it is not altogether certain that the observed neutrons come from a thermonuclear reaction, and experiments are continuing to study the details of neutron producing processes.

In order to obtain a net gain in energy from the reaction it would be necessary to heat deuterium gas to temperatures in the region of 100 million deg. C., and to maintain it at that temperature long enough for the nuclear energy released to exceed the energy needed to heat the fuel and that lost by radiation. Lower temperatures of some 40 million deg. C. would suffice for a deuterium-tritium mixture. The high temperatures achieved in ZETA, and the relatively long duration for which the hot gas has been isolated from the tube walls are, therefore, the most important experimental results obtained so far. Whilst a much longer time (perhaps several seconds) is required for a useful power output there appears to be no fundamental reason why these longer times, together with much higher temperatures, cannot be achieved.

These latter points were stressed in a statement made by Sir John Cockroft, director of the Atomic Energy Research Establishment, at a Press conference held at Harwell. He went on to say that while they were experimenting with ZETA, improving it and studying its performance, they would be designing and building its successor which would aim at achieving the " break-even " point. They intended to increase the current circulating in ZETA by the provision of more condensers ; the temperatures should then rise substantially. If and when they reach a temperature of 25 million degrees, the number of neutrons per pulse should increase at least 10,000 times. Even then, the amount of energy produced would be small compared with the energy input.



Sceptre III, the small torus or electrical discharge chamber, in which the hydrogen fusion reaction has been controlled at the A.E.I. research establishment, Aldermaston.

Earlier in his statement Sir John had referred to the work achieved as stage 1. Reaching the " break-even " point would be stage 2, and in this there would be many problems to face. New methods may have to be devised to heat the gas to higher temperatures and new techniques required to measure the temperatures. Even if all went well, they would still have the further engineering problem of designing and constructing a prototype of a practical and economic thermonuclear power station. This would be stage 3, and after that, there would be stage 4, viz. commercial application.

Sir John Cockroft made reference to the help and

co-operation received from the A.E.I. group at Aldermaston. Here the apparatus resembled a baby edition of ZETA—using a torus of about three times smaller bore—and work would continue there to see how far temperatures could be increased with smaller and less expensive systems. Close and friendly co-operation also existed with American scientists working with the same objective as themselves, but on three or four separate lines. At Princeton University, the so-called "Stellarator" project had resulted in temperatures of 1.2 million degrees being observed in a race-track type of tube of 4-in. bore, while at the Los Alamos Scientific Laboratory, the so-called Columbus apparatus—straight tubes through which currents of up to a million amperes are passed in a very short pulse of a few millionths of a second—had produced up to a hundred million neutrons in a single pulse. Estimates of the temperature range were from 3 to 5 million degrees. Details have also been released from Los Alamos describing work with a quite small torus of 2-in. bore, known as the Perhapsatron and using an axial magnetic field rather stronger than the ZETA stabilising field. Pulses of currents of up to 200,000 amp, up to 60 millionths of a second were passed through the conducting gas channel. Up to a million neutrons per pulse were observed. This neutron emission would be consistent with a temperature of about 6 million degrees, but temperatures were not measured.

All the work reported was on the same general principle of producing a "pinched" discharge stabilised by an axial magnetic field. Over a million neutrons per pulse were produced in all cases, but in no case had they been proved to be true thermo-nuclear neutrons. Temperatures had been measured spectroscopically only in ZETA and SCEPTRE III, and these were in the thermo-nuclear region of 2 to 5 million degrees.

In conclusion, Sir John said that the Perhapsatron work in the United States, together with the results obtained in this country, enabled them for the first time to see the effect of the size of the apparatus on performance. An examination of the performance of the three tori of increasing size would provide them with a good guide for a future line of development, and the conditions required to increase the time during which the high temperatures persist. Long containment times were as important as high temperatures for practical results and one of the future objectives would be to achieve much longer containment times as well as "break-even" temperatures. The performance of ZETA had encouraged them to believe that this would be possible.

The zero-energy thermal assembly was constructed by Metropolitan-Vickers Electrical Co. Ltd. This company also collaborated in the actual design of the equipment.

SCEPTRE III

SCEPTRE III is an aluminium toroidal tube made of 12-in. dia. tubing, with a mean torus dia. of 45-in., and threaded by an iron core weighing 4-ton. Numerous experiments have been performed with this apparatus discharging into it energies up to 40,000 joules ; currents up to 200,000-amp have been generated and, as previously stated, temperatures of nearly 4 million deg. C. have been measured. At temperatures of from 2.3 to 3.8 million degrees, neutrons are emitted copiously over a time of several hundred microseconds during which time the discharge channel appears to be stable. Experiments have been performed to establish the conditions under which neutrons are emitted, the manner in which the number emitted varies with gas pressure, gas temperature, and with different values of the stabilising magnetic field, and the company are continuing with improving the efficiency of the use of electrical energy to achieve a plasma of even higher temperature.

This work is part of a great volume of nuclear physics which the A.E.I. company is now undertaking, and has undertaken in smaller measure at Aldermaston since the inception of the laboratory in 1947. The nuclear physics section has developed apparatus for accelerating atomic particles to very high velocities, and has made important contributions to nuclear science in this field. More recently they decided to design and construct a medium-powered nuclear reactor—a so-called "swimming-pool" reactor, christened in Aldermaston "MERLIN"—for future research on many aspects of reactors.

CENTRAL ELECTRICITY GENERATING BOARD

Mr. F. J. Lane, O.B.E., M.Sc., M.I.E.E., chief transmission engineer of the Central Electricity Generating Board, relinquished his post at the end of February to join the partnership of Messrs. Preece, Cardew and Rider, the well-known consulting engineers. Mr. Lane has served for 27 years in the electricity supply industry, 24 years of which were spent at the headquarters of the Central Electricity Board and the Central (formerly British) Electricity Authority. He was appointed transmission design engineer to the authority in March, 1948, and was made deputy chief engineer (transmission) in 1954. In these positions, he has been very closely concerned with the design, development and construction of the 275-kV super-grid, and with the investigations leading up to the decision to lay across the English Channel, the cable linking the electricity supply systems of Britain and France.

Mr. J. L. Egginton, B.Sc., M.I.E.E., system design engineer of the South of Scotland Electricity Board, has been appointed chief transmission engineer of the Central Electricity Generating Board in succession to Mr. Lane, with effect from March 1st, 1958. Mr. Egginton subsequently served an apprenticeship with the English Electric Company at Stafford. After a few years in the sales department of that firm he joined Messrs. Kennedy & Donkin in 1928, and for seven years worked on the construction of the grid system. In 1935, he was appointed an asssitant engineer in the headquarters of the Central Electricity Board. When the industry was nationalised in 1948, he went to Edinburgh as chief assistant engineer (systems design) of the South-East Scotland Electricity Board. This board was superseded by the South of Scotland Electricity Board in 1955, and since that year Mr. Egginton has been working in Glasgow as systems design engineer, responsible for the design of all transmission and distribution systems from 275-kV down to low tension, in the south of Scotland.

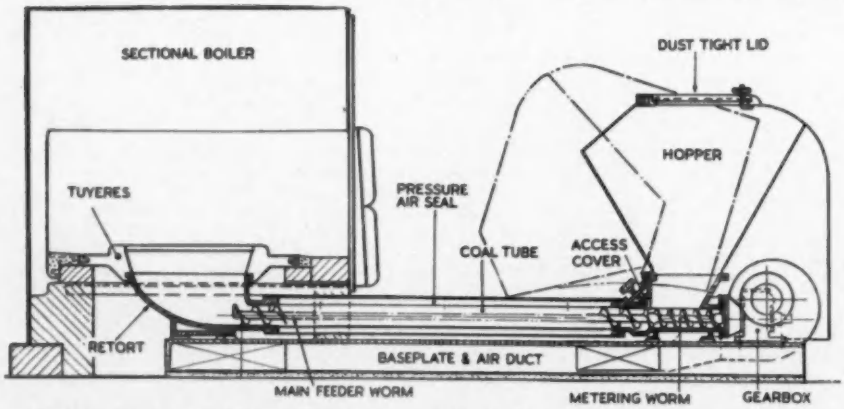
MECHANICAL HANDLING EXHIBITION

The 1958 Mechanical Handling Exhibition & Materials Handling Convention to be held at Earls Court, London, from May 7th-11th, will, it is claimed, be the largest display of labour-aiding equipment and methods ever presented. Occupying half-a-million square feet of floor space, the exhibition will, for the first time, be international in character, with over 250 exhibitors from Great Britain, America, France, Germany, Italy and Scandinavia. At the Materials Handling Convention, running concurrently, leading authorities will present papers dealing with the latest handling methods in particular industries. This is an exhibition of the greatest interest and importance to all concerned with production. The exhibits will include examples of the latest conveying and handling devices, cranes, industrial trucks, aerial ropeways, earth moving equipment, lifting tackle and all types of equipment and accessories associated with mechanical handling. Further information, details of the many facilities available to visitors, and tickets, can be obtained from the Exhibition Manager, Dorset House, Stamford Street, London, S.E.1.

An Improved Underfeed Stoker

THE screw-type of underfeed stoker is probably one of the best known appliances for the mechanical firing of solid fuel. In principle it has changed little since its inception, although attempts have been made to introduce alternatives to the Archimedean screw. One immediately calls to mind various "ram-feed" mechanisms, some of which have novel features, but in the main these machines tend to be more expensive to build, involving, as they do, some form of reciprocating device. On the other hand, the simpler screw-type stoker offers the advantage of economy of production and simplicity of operation. Moreover, there is little to cause failure of the machine, and the addition of automatic control equipment can be cheap and effective so that the machine may be left for comparatively long periods of time with virtually no attention. Unfortunately, this machine has three inherent disadvantages; and although efforts have been made to overcome them, it is in only comparatively recent years that a stoker has been designed in which all have been successfully eliminated. The main difficulties with "underfeed" firing may be summarised as follows:

(1) The fuel tends to pack tightly in the coal-conveying tube.
(2) Under certain conditions there is a tendency for smoke to be forced back into the receiving hopper.
(3) There may be slight smoke emission at times of starting-up and shutting-down when control is exercised by simple thermostat or pressurestat.



Sectional outline arrangement of the Hodgkinson "Meterfeed" underfeed stoker.

To overcome the first problem, the "Meterfeed stoker" is built with two coaxial worms in tandem—one with a fine and one with a coarse pitch (Fig. 1). The former rotates immediately below the hopper and discharges measured quantities of fuel to the latter. The second screw turns at the same speed but since the pitch is greater, the material is conveyed at a higher rate—therefore, the flights are only partially filled. The effect is to reduce the mechanical load on the gearbox, and a friable coal is not pulverised in transit to the same extent as when it is subjected to combined compression and movement.

The second difficulty is not so easy to resolve. Unfortunately, practically all underfeed stokers appear to be prone to the seepage back of fumes to the hopper from the distillation zone in the retort. Sometimes the quantity is small, in which case the tendency can be controlled by means of a supply of air introduced into the coal feed system near the throat of the retort. Occasionally these fumes are most objectionable, and they can only be completely eradicated by almost closing the forced-draught fan damper. The emission of smoke from the hopper of an underfeed stoker is usually particularly offensive and intractable when the hopper is nearly empty or when the coal-conveying system is only partially full. Since the main principle of the Meterfeed stoker is based on a partially-filled worm it was more than ever essential to provide a means whereby the danger of the leakage back of gas could be excluded. Hence, a considerable amount of research was devoted to this problem before the stoker became a feasible proposition at all.

Obviously it is not possible to introduce a mechanical seal anywhere in the coal-conveyor system. There is, therefore, only one practicable alternative—the coal tube must be maintained at a higher static pressure than the distillation zone at the retort. Thus, the air tends to flow towards the fire instead of fumes being permitted to travel in the reverse direction. There was one feature of the Meterfeed stoker of which advantage could be taken. That was the position each packet of fuel assumed between the flights of the worm. It will be seen from Fig. 2 that if the screw is rotating in an anti-clockwise direction the coal surface tends to fall at the left and to rise on the right. There is a space above each mass. If, therefore, it is required to maintain the air in the coal tube at the highest possible pressure, the supply must enter along an axis set at an angle corresponding to eleven o'clock. This ensures that the coal offers the least obstruction and, moreover, there is little likelihood of particles falling back into the air entry ports. In actual fact, three ports are provided, one near the retort—the conventional position—one just behind the hopper, and a third midway

between the other two. To avoid losses due to the passing of this supply of subsidiary air through a pipe with sharp corners at elbows and tees, a sleeve is fitted over the coal-conveyor itself. Through this annulus formed between the two tubes, the air can be passed at high-pressure without fear of encountering frictional losses. The annulus is fed from a scoop placed in a converging duct immediately after the forced-draught fan. Having made these provisions, it was found that even with a partially-filled coal tube, an empty hopper and full forced-draught, " smoking back " did not occur.

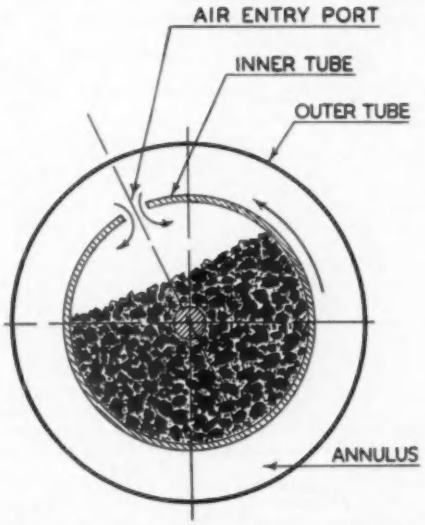


Diagram showing that if feed screw is rotating in an anti-clockwise direction, the coal surface tends to fall at the left and to rise on the right.

Probably 95 per cent. of all underfeed stokers commissioned in this country are controlled by a simple thermostat or pressurestat. This system, however, does present one difficulty. There is a danger that smoke will be emitted if the stoker is suddenly stopped, and possibly an additional risk when the machine is re-started. The smoke tendency is due, in the first place, to the sudden interruption of the supply of air whilst there is still some green coal in the retort. From this coal, volatile matter will be liberated due to the radiation from the overlying coke bed. In the second instance, when firing is resumed, green coal is immediately deposited in the retort, where it undergoes initial heating. Although the temperature is high enough to release a proportion of the hydro-carbons, it is not sufficiently high to promote complete oxidation ; and, therefore, smoke production is the result.

Clearly, therefore, in order to solve these two problems and to ensure smokeless operation under all conditions, two provisions are essential.

(a) A supply of oxygen must be available for at least 30 sec. after the injection of green coal has ceased.
(b) The temperature of the combustion chamber must be raised before feeding is re-commenced.

To fulfil these requirements, the Meterfeed stoker has been designed with two separate motors. One is used to drive the coal-feed mechanism, and the other the forced-draught fan. Each motor has its own contactor and the two are linked by means of a pneumatic dashpot delay gear. The sequence is as follows :—On attaining the required temperature or pressure, the control breaks a contact which instantly trips the motor responsible for driving the fuel feed to the retort. The forced-draught fan continues to run, however, so that volatiles released from the fuel just introduced into the retort are supplied with air for a period of up to 2 min. The length of the interval can be adjusted to suit the properties of the coal being fired. Conversely, when the temperature or pressure falls to a pre-determined value, the control system reacts by first " tripping in " the forced-draught fan. This has the effect of rapidly raising the temperature of the coke forming the fuel-bed in readiness for the resumption of firing. After a pre-set delay, which can be as short as a few seconds or as long as 2 min., the second motor is automatically started. Only then can the liberation of smoke-forming products begin and by that time the combustion zone will have been raised to a temperature consistent with complete oxidation.

The advantages of having in the one stoker separately controlled and driven coal and air supplies must now be apparent. There remains, however, one difficulty—that of cost. How is a machine to be built embracing this one desirable feature—a feature which must necessarily be expensive—and yet be so designed that it could be produced at a competitive price? Fortunately, there is one major item in the conventional stoker which can be sacrificed. In fact, its elimination so far from detracting from the value of the unit could be considered a distinct advantage. Up to now, practically all underfeed machines have been fitted with some form of change-speed mechanism. This is inevitably a costly assembly and, moreover, it could introduce maintenance problems in the event of a breakdown. By substituting a much simpler gearbox, consisting of a single reduction worm

Rear-end view of the U.C. model twin-screw, twin-retort " Meterfeed " stoker. This particular unit has a rating of from 400 to 700 lb./hr.

and wheel, the cost of the whole machine is greatly reduced. Not only is there a saving in initial expenditure, but standard gearboxes are obtainable from stock from most gear-manufacturing specialists. Thus the proposition is doubly attractive since lower numerical stocks of components become possible, and the cost of the second motor was easily recouped.

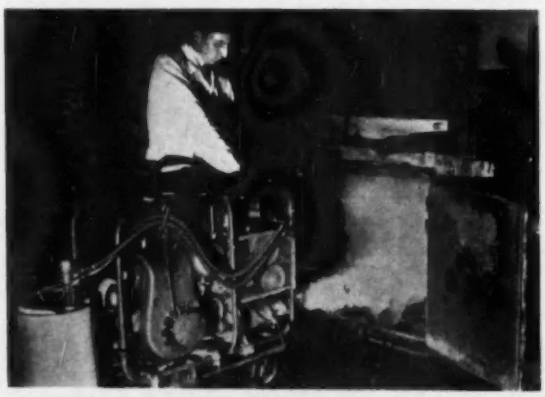
There remained, however, one further problem: that of providing variation in the rate of coal feed. Here, again, the independent motor drive proved invaluable, since with the conventional design of stoker the operator is usually confined to only three or four speeds (it is true that on the very large sizes there may be as many as six speeds) by operating the coal-feed driving motor on a recurring time cycle, a far wider range is immediately obtainable. The duration of the cycle averages about 1 min., but during each minute, the coal can be fed for any number of seconds or even fractions of a second. Thus, by simply setting a dial, it is possible to control the rate of fuel delivery from virtually zero to the maximum hourly rating of the boiler. By this means, far greater flexibility is placed at the disposal of the operator, who can regulate the heat input to within extremely fine limits. The Meterfeed stoker, which is covered by British Patents Nos. 727168 and 727169, is now being exported in considerable numbers. In view of the recent legislation on air pollution, it will offer a very strong appeal to prospective users in this country.

In conclusion, we should acknowledge our indebtedness to Mr. J. P. Lauder, B.Sc.(Tech.), M.Inst.F., Technical Director, James Hodgkinson (Salford) Ltd., for supplying much of the technical information in this article.

FOG METHOD OF TESTING BOILERS

The methods used to detect air leaks in boiler brickwork and casings are varied, ranging from the flame of a candle, or soapy water—the favoured but most laborious processes of the past—to the use of smoke bombs and compressed air. Smoke bombs are a comparatively recent innovation. They are placed in the furnace, and, after burning for some time, a pressure of up to one 1-in. w.g. is built up in the boiler, and this forces the smoke out of any leaks that are present. Testing cannot be carried out, however, until sufficient time has elapsed for the boiler to cool down (sometimes as long as 24 hours), and allow a man to enter the furnace to place the bombs, and again, there is no way of regulating the amount of smoke generated once the bombs have been ignited. These disadvantages in an otherwise satisfactory system have now been overcome by the use of the Lister-Todd Engineering Corporation Ltd. TIFA fog-making machine. The machine, which was originally designed for the dissemination of insecticides in aerosol form, is mounted on a trolley. It is extremely compact, and with an overall weight of 250-lb., can be easily moved to work on any boiler gallery, while awkward positions are reached simply by attaching extra lengths of metallic hose. The amount of fog emitted into the furnace can be controlled by the operator, and as the material used for producing a fog (Shell FR80 hydraulic fluid, for instance) will not in itself sustain combustion, tests can be started within an hour or so of drawing the furnace fire. This latter factor not only reduces appreciably the time required for detecting and sealing air leaks, but enables tests to be carried out under conditions most closely resembling those of a boiler in operation.

The TIFA method of boiler testing was developed by one of the major public utility companies in the U.S.A. in conjunction with the Products Division of the Todd Shipyard Corporation, the makers of the original TIFA machine, and since the Lister Todd Engineering Corporation Limited, of Dursley, Gloucestershire, introduced the method to the United Kingdom, their lightweight TIFA machines have been supplied to eight of the eleven divisions of the former Central Electricity Authority. The fogging procedure is simple and requires little preparation. Following the closing of all boiler dampers, observation doors and any other apertures, a flexible metallic hose connected to the fogging head of the machine is inserted into a convenient opening, the point of entry being suitably sealed to prevent the escape of fog. As fog builds up inside the boiler it emerges through air leaks and is readily visible to maintenance staff who can seal the leaks immediately or mark them for future repair. The natural draught of the boiler, together with the air-blast of the machine, is normally sufficient to disperse the fog through major leakage points, but it may be necessary to pressurise the boiler up to a maximum of 0.5 in. w.g. to force fog through very fine leaks. The amount of fog required necessarily depends on the size of the boiler, but the lightweight TIFA produces approximately 10,000 cu. ft./min., and on this basis a boiler of 100,000 cu. ft. capacity would need ten minutes treatment. In practice, however, boiler plant engineers have found that three to four minutes fogging is sufficient in the first instance, and this can be followed with short bursts of fog to complete the detection of all existing leaks. The method also makes it possible to check any specialised section of a boiler system, as for example, a superheater, by isolating this section and introducing the fog through a suitable opening.



Fog generated by a lightweight TIFA unit is shown being introduced directly through the ash-pit door of a boiler furnace.

British Plant for South America

The condensing, feed-heating, distilling and de-aerating plants, together with boiler feed-pumps, and circulating-pumps for the five 120-MW turbo-alternator sets for the new Buenos Aires Power Station will be manufactured by **Worthington Simpson Ltd.**, Newark-on-Trent, Notts. They will also provide the circulating-water pumps, screening plant and other associated equipment at the river water intake. The complete contract (valued at £30 million) for this station, which is being built for Agua y Energia Electrica (E.N.D.E.), Buenos Aires, has been awarded jointly to the British Thompson-Houston Export Co. Ltd., and International Combustion Ltd.

Warwickshire Education Committee have announced the receipt of the first instalment of a gift of £25,000 made by the **British Thomson-Houston Company** to the Rugby College of Technology and Arts, as a part payment of the cost of the "Halls of Residence" now being erected in the college grounds. The steady growth in the importance of Rugby College as a centre of technical education has always been accompanied by close co-operation with industry, in which work the BTH Company has played a prominent part. The establishment of sandwich courses for students in the engineering technologies and for which the Halls of Residence are being provided (the first, it is thought, to be built by a technical college) is a noteworthy landmark in the relations between a technical college and an industrial concern.

RECENT Equipment AND Accessories

A new dissolved-oxygen recorder

In modern steam generating equipment, corrosion, due to dissolved-oxygen present in the feedwater, can, of course, cause rapid failure of boiler tubes and ancillary gear. It has, therefore, become essential to control the oxygen content to prescribed limits, and a new dissolved-oxygen recorder has been designed for this purpose by Wallace & Tiernan Ltd. The new recorder is a proven, robust commercial instrument that is claimed to eliminate all the disadvantages of measurement by chemical reagent response or oxygen "scrubbing." Employing the amperometric method, it gives a direct linear response to changes in the oxygen content determined through variation in current flow between two electrodes. It is equipped with automatic wide range and fine control temperature compensation. In addition, interference and "drift" are eliminated through the use of a "bombardment" cell, by which a continual re-circulation of fine grit particles ensures that the surfaces of the electrodes are maintained in a clean condition with a resultant constant sensitivity. A saturated salt solution increases conductivity, and thereby assists the accuracy of measurement and recording. The sample water itself serves the saturator and thus prevents "contamination." A built-in electrolytic calibration cell is employed to inject a known oxygen concentration into the sample water for simple calibration checks, while visual devices indicate correct sample water and salt solution flows. A completely enclosed system, and the use of stainless steel and chemically inert materials for flow lines and controls, eliminate atmospheric and chemical interference. The recorder can be arranged for selected scale ranges between 0 to 1.0 and 0 to 0.01 p.p.m. with scale divisions by increments of 1/100 of the full-scale deflection. Summarising, the Wallace & Tiernan dissolved-oxygen recording equipment would appear to offer the following advantages :— (1) provision of a permanent record ; (2) check against irregularities in the system ; (3) check against inefficient operation of de-aerators, regenerative condensers and air extractors ; (4) rapid response to oxygen changes, provision of daily operating data not available by periodic testing. (*Wallace & Tiernan Ltd., Power Road, London, W.4.*)

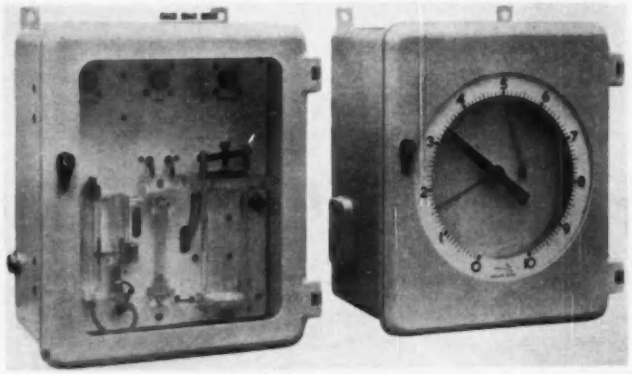


Fig. 1. Two views of the new Wallace & Tiernan dissolved-oxygen recorder. (Wallace & Tiernan Ltd.)

New Dall orifice

George Kent Ltd. announce the introduction of the "Dall orifice," the latest addition to their range of differential-pressure producing devices. This is intermediate both in pressure loss and in cost between the square-edged orifice plate and the Dall tube. It is thus particularly suitable for use where pressure recovery is of importance, but space or first cost precludes the use of a Dall tube. The company point out that a comparison of the pressure losses incurred by various differential-pressure producers shows that on a medium-velocity installation working with a 100-in. w.g. instrument, the pressure loss with a Dall orifice would be only 19-in. w.g. compared with 60-in. w.g. for an ordinary orifice plate or flow nozzle. (With a Dall tube, the loss would be 5-in. w.g.) The orifice is a self-contained, truncated form of Dall tube, and has a thickness (where it is clamped between the pipe flanges) of only $1\frac{3}{8}$-in. The overall length is 0.3 of the pipe dia., and the downstream cone simply projects a short way into the downstream pipe. The design is such that the essential features of the Dall tube have been retained, while the shorter downstream cone gives the desired compromise between cost, space saving and pressure recovery. The pressure tappings are taken out through the rim, and there are drain and/or vent holes through the orifice, thus avoiding the need for separate drains or vents. The new equipment is at present available for 6-in. to 24-in. pipes, and is normally cast in gunmetal ; but high-grade cast-iron can be used for some applications on 18-in. and larger sizes. The fluids for which the Dall orifice is suitable are similar to those for the tube—namely, water other than sewage, compressed-air, low-pressure air, relatively clean and non-corrosive gases, and low-pressure steam such as exhaust steam. The normal installation requirements are as those for other differential - pressure producers. (*George Kent Ltd., Luton, Beds.*)

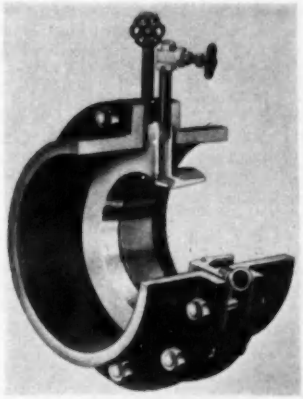
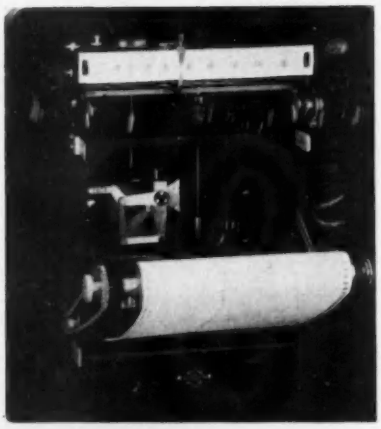


Fig. 2. A cut-away view of the new Kent Dall orifice. (George Kent Ltd.)

An electronic recorder/controller

The Cambridge Instrument Co. Ltd. "DE" electronic recorder/controller can be supplied in conjunction with complete Cambridge equipment for a large number of applications in power stations and boiler plants, especially where the main requirement is for a high-performance instrument which is reliable in service and simple to maintain. It will measure any quantity that can be converted into a small d.c. signal and employs a powerful closed-loop servo-mechanism of high sensitivity, accuracy, and fast speed of response. Normal servicing comprises only pen filling, chart changing, and periodical gear lubrication. The self-contained plug-in amplifier unit can be easily replaced, and the range altered on site, simply by unsoldering and resoldering seven conveniently-placed connections. Hand change gears are used to select chart speeds which range from ½-in./hr. to 6-in./min. Single-point models from the "DE" range employ a glass syphon pen which draws a continuous line, while multi-point models incorporate a turret-pen with ink reservoirs for 2, 3, 4, 6, 8 or 12 points. Single-point models may have up to six independently adjustable cams operating SPCO microswitches at predetermined recorder settings (for control, alarm, warning lights, etc.). Six-point models may have cams arranged to provide "on-off" control on all points independently. Pneumatic proportional control providing a proportional band adjustable between 2 and 600 per cent. or transmitting directly into a 3-term controller is also available. The recorder forms an integral part of the following complete Cambridge systems. *Temperature* :— Complete pyrometer equipment employing thermocouples or resistance-thermometers (or radiation pyrometers). Calibration is in deg. F. or deg. C. Thermocouple ranges are up to 1,600 deg. C. with automatic cold-junction temperature compensation down to 100 deg. C. (50 deg. C. for special applications) of full scale. Resistance thermometer ranges are up to 550 deg. C. with a minimum range down to 10 deg. C. of full scale. *CO_2 and O_2 analysis in flue gases* :—(1) Complete CO_2 analysing equipment, including recorder, bubbler aspirator, katharometer bridge, mains unit, etc., with a normal range of 0-20 per cent. CO_2. (2) Magnetic oxygen analysing outfits, with a normal range of 0-10 per cent. O_2, based on the para-magnetic properties of oxygen and including analyser unit, recorder, mains unit, etc. (3) A combined temperature/CO_2 recording outfit with up to three records on each side of a split chart, with normal ranges of 0-1,000 deg. F. and 0-20 per cent. CO_2. *Conductivity, pH, and dissolved-oxygen determinations in boiler-feed water* :—(1) Complete single or two-range conductivity recording outfits with an entirely new range of submersible, continuous-flow, or high-pressure electrode systems. Normal ranges are 0-20 reciprocal megohms for boiler input, 0-5 reciprocal megohms for condensate. The high-pressure electrode system is rated for pressures up to 2,500 lb./sq. in. (2) Complete pH recording outfit including thermionic potentiometer, recorder, continuous flow or submersible electrode systems, etc., with a normal range of 5-10 pH. (3) Complete gas-phase transfer-type electro-chemical dissolved oxygen recording equipment comprising recorder, analyser, control panel, mains unit, flow regulator, and water cooler. This outfit, which is specific to oxygen, has at least as high a sensitivity and stability as any method of chemical analysis available industrially and is capable of recording concentrations of the order of 0.001 p.p.m. (*Cambridge Instrument Co. Ltd.*, 13, *Grosvenor Place, London, S.W.*1.)



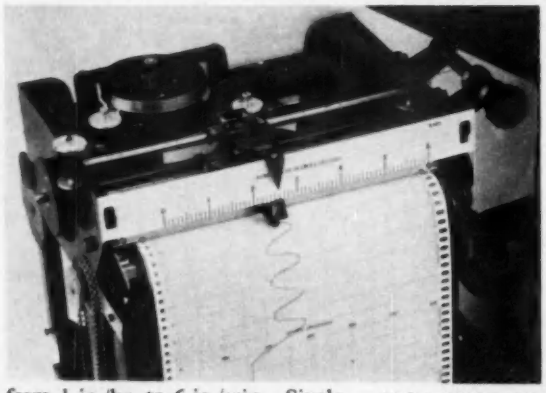


Fig. 3 (above). The "DE" electronic recorder/controller arranged as a single-point pneumatic proportional controller.

Fig. 4 (left). The "DE" electronic recorder/controller, single-point, electrical ON-OFF control, showing measured and desired value pointers, control cam pulley wheel, desired value pointer adjustment, etc. (Cambridge Instrument Co. Ltd.)

New flame-failure equipment

In the February, 1958, issue of this journal we included under the above heading a description of the FSM4 flame-failure and ignition programme control unit recently introduced by Elcontrol Ltd. This is a fully-automatic controller for use with practically any type of industrial oil or gas-burning equipment that is required to start up automatically by remote control or time-clock. We now include the illustration, Fig. 5, which shows the unit chassis withdrawn from its casing. The chassis may also be supplied for mounting in a control cubicle or cabinet. (*Elcontrol Ltd.*, 10, *Wyndham Place, London, W.*1.)

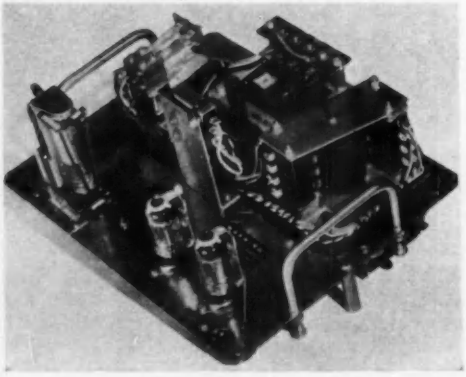


Fig. 5. The unit chassis of the FSM4 flame-failure and ignition programme control equipment shown withdrawn from its casing. (Elcontrol Ltd.)

New plastic packing for cooling towers

In the January, 1958, issue of this journal we published details of the Fluor " Counterflo " induced-draught cooling tower. Head Wrightson Processes Limited, who are responsible for the design, supply and erection of these towers in this country and the British Commonwealth (excluding Canada), announce that their American Associates, Fluor Products Company, of Los Angeles, U.S.A., have designed a new plastic " Poly-grid " packing for the " Counterflo " cooling tower. This packing produces a greater cooling surface, and an increased flow of heat transfer than is possible with the standard timber grid decks at present in common use. The construction of the new grid is open and the pressure drop low, and " Poly-grid " packing permits more water to be cooled, or a greater degree of cooling under existing operating conditions. It is also announced that further research has resulted in the development of asbestos panels for the construction of the tower walls as an alternative to timber panels and off-set louvres which decrease the pressure drop of the air drawn into the tower. Additionally, winter operation is improved, as the icing problem formerly associated with louvres adjacent to the tower columns is eliminated. " Counterflo " cooling towers have been installed at the nuclear research stations at Harwell, Dounreay, Sydney, N.S.W., and Risø Denmark, and at power stations, etc., in many parts of the world. (*Head Wrightson & Co. Ltd., Ship House, 20, Buckingham Gate, London, S.W.1.*)

Mr. Eric H. Ball, M.I.E.E., managing director of the British Thomson-Houston Company, who was appointed a Commander of the Order of the British Empire (C.B.E.) in H.M. the Queen's New Year Honours, spent his early years in Pretoria and came to the British Isles in 1910. He was educated at Victoria College, Jersey, and received technical training at Faraday House, which was interruped by service in the Royal Engineers during the First World War. He received his practical training in mechanical and electrical engineering with notable British firms, joining the commercial engineering staff of BTH Export Department in June 1923. Mr. Ball became head of the Industrial Section of that department in 1927. In 1932 he was appointed manager Transformer (Sales) Department, being responsible for both home and overseas business in power transformers and ancillary equipment. In 1946 he was appointed deputy managing director of BTH, and in 1948 became managing director of the company and a director of Associated Electrical Industries Ltd. Mr. Ball is also chairman of the British Thomson-Houston Export Co. Ltd., the British Thomson-Houston Co. (South Africa) (Pty.) Ltd. and the British Thomson-Houston Co. Central Africa (Pty.) Ltd., the British Thomson-Houston Co. (Canada) Ltd., A.E.I. Lamp & Lighting Co., and of Birlec Ltd.

* * *

Danfoss Manufacturing Co., 13, Queensway, London, W.2, inform us that they have recently introduced the Danfoss AT Clip-on Thermostat which will meet an urgent need in the heating industry for an instrument which, besides being efficient and of low cost, is particularly simple to install. Having a breaking capacity of 6 amps a.c. with change-over contacts, it will find a wide range of application for the control of oil-burners, motorised valves, dampers, etc. Delivery is ex stock, and we understand that literature will be available shortly.

* * *

Mr. L. H. Cooper, chairman of The Mond Nickel Company Limited and vice-president of The International Nickel Company of Canada Limited, has been elected a director of that company.

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It is announced by George Kent Ltd., that **Mr. W. T. H. Carter** has been appointed chief buyer for the Instrument Division of the company.

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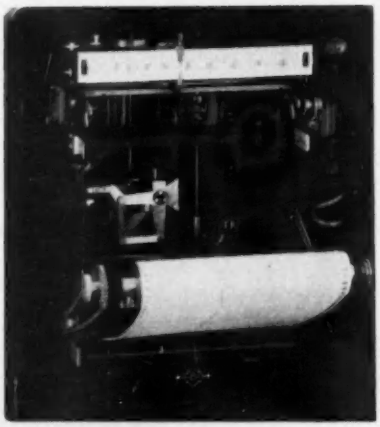
An electronic recorder/controller

The Cambridge Instrument Co. Ltd. "DE" electronic recorder/controller can be supplied in conjunction with complete Cambridge equipment for a large number of applications in power stations and boiler plants, especially where the main requirement is for a high-performance instrument which is reliable in service and simple to maintain. It will measure any quantity that can be converted into a small d.c. signal and employs a powerful closed-loop servo-mechanism of high sensitivity, accuracy, and fast speed of response. Normal servicing comprises only pen filling, chart changing, and periodical gear lubrication. The self-contained plug-in amplifier unit can be easily replaced, and the range altered on site, simply by unsoldering and resoldering seven conveniently-placed connections. Hand change gears are used to select chart speeds which range from ½-in./hr. to 6-in./min. Single-point models from the "DE" range employ a glass syphon pen which draws a continuous line, while multi-point models incorporate a turret-pen with ink reservoirs for 2, 3, 4, 6, 8 or 12 points. Single-point models may have up to six independently adjustable cams operating SPCO microswitches at predetermined recorder settings (for control, alarm, warning lights, etc.). Six-point models may have cams arranged to provide "on-off" control on all points independently. Pneumatic proportional control providing a proportional band adjustable between 2 and 600 per cent. or transmitting directly into a 3-term controller is also available. The recorder forms an integral part of the following complete Cambridge systems. *Temperature* :— Complete pyrometer equipment employing thermocouples or resistance-thermometers (or radiation pyrometers). Calibration is in deg. F. or deg. C. Thermocouple ranges are up to 1,600 deg. C. with automatic cold-junction temperature compensation down to 100 deg. C. (50 deg. C. for special applications) of full scale. Resistance thermometer ranges are up to 550 deg. C. with a minimum range down to 10 deg. C. of full scale. *CO_2 and O_2 analysis in flue gases* :—(1) Complete CO_2 analysing equipment, including recorder, bubbler aspirator, katharometer bridge, mains unit, etc., with a normal range of 0-20 per cent. CO_2. (2) Magnetic oxygen analysing outfits, with a normal range of 0-10 per cent. O_2, based on the para-magnetic properties of oxygen and including analyser unit, recorder, mains unit, etc. (3) A combined temperature/CO_2 recording outfit with up to three records on each side of a split chart, with normal ranges of 0-1,000 deg. F. and 0-20 per cent. CO_2. *Conductivity, pH, and dissolved-oxygen determinations in boiler-feed water* :—(1) Complete single or two-range conductivity recording outfits with an entirely new range of submersible, continuous-flow, or high-pressure electrode systems. Normal ranges are 0-20 reciprocal megohms for boiler input, 0-5 reciprocal megohms for condensate. The high-pressure electrode system is rated for pressures up to 2,500 lb./sq. in. (2) Complete pH recording outfit including thermionic potentiometer, recorder, continuous flow or submersible electrode systems, etc., with a normal range of 5-10 pH. (3) Complete gas-phase transfer-type electro-chemical dissolved oxygen recording equipment comprising recorder, analyser, control panel, mains unit, flow regulator, and water cooler. This outfit, which is specific to oxygen, has at least as high a sensitivity and stability as any method of chemical analysis available industrially and is capable of recording concentrations of the order of 0.001 p.p.m. (*Cambridge Instrument Co. Ltd.*, 13, *Grosvenor Place, London, S.W.*1.)



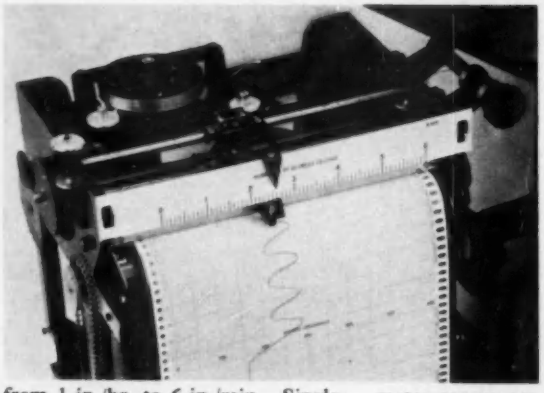


Fig. 3 (above). The "DE" electronic recorder/controller arranged as a single-point pneumatic proportional controller.

Fig. 4 (left). The "DE" electronic recorder/controller, single-point, electrical ON-OFF control, showing measured and desired value pointers, control cam pulley wheel, desired value pointer adjustment, etc. (Cambridge Instrument Co. Ltd.)

New flame-failure equipment

In the February, 1958, issue of this journal we included under the above heading a description of the FSM4 flame-failure and ignition programme control unit recently introduced by Elcontrol Ltd. This is a fully-automatic controller for use with practically any type of industrial oil or gas-burning equipment that is required to start up automatically by remote control or time-clock. We now include the illustration, Fig. 5, which shows the unit chassis withdrawn from its casing. The chassis may also be supplied for mounting in a control cubicle or cabinet. (*Elcontrol Ltd.*, 10, *Wyndham Place, London, W.*1.)

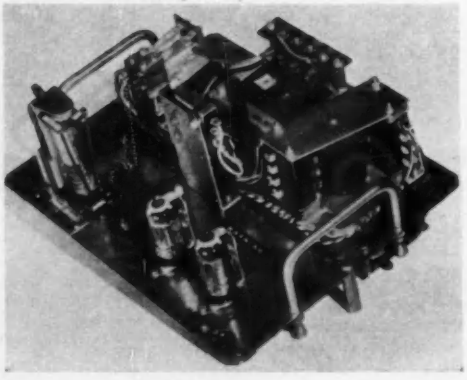


Fig. 5. The unit chassis of the FSM4 flame-failure and ignition programme control equipment shown withdrawn from its casing. (Elcontrol Ltd.)

New plastic packing for cooling towers

In the January, 1958, issue of this journal we published details of the Fluor " Counterflo " induced-draught cooling tower. Head Wrightson Processes Limited, who are responsible for the design, supply and erection of these towers in this country and the British Commonwealth (excluding Canada), announce that their American Associates, Fluor Products Company, of Los Angeles, U.S.A., have designed a new plastic " Polygrid " packing for the " Counterflo " cooling tower. This packing produces a greater cooling surface, and an increased flow of heat transfer than is possible with the standard timber grid decks at present in common use. The construction of the new grid is open and the pressure drop low, and " Poly-grid " packing permits more water to be cooled, or a greater degree of cooling under existing operating conditions. It is also announced that further research has resulted in the development of asbestos panels for the construction of the tower walls as an alternative to timber panels and off-set louvres which decrease the pressure drop of the air drawn into the tower. Additionally, winter operation is improved, as the icing problem formerly associated with louvres adjacent to the tower columns is eliminated. " Counterflo " cooling towers have been installed at the nuclear research stations at Harwell, Dounreay, Sydney, N.S.W., and Risø Denmark, and at power stations, etc., in many parts of the world. (*Head Wrightson & Co. Ltd., Ship House, 20, Buckingham Gate, London, S.W.1.*)

Mr. Eric H. Ball, M.I.E.E., managing director of the British Thomson-Houston Company, who was appointed a Commander of the Order of the British Empire (C.B.E.) in H.M. the Queen's New Year Honours, spent his early years in Pretoria and came to the British Isles in 1910. He was educated at Victoria College, Jersey, and received technical training at Faraday House, which was interruped by service in the Royal Engineers during the First World War. He received his practical training in mechanical and electrical engineering with notable British firms, joining the commercial engineering staff of BTH Export Department in June 1923. Mr. Ball became head of the Industrial Section of that department in 1927. In 1932 he was appointed manager Transformer (Sales) Department, being responsible for both home and overseas business in power transformers and ancillary equipment. In 1946 he was appointed deputy managing director of BTH, and in 1948 became managing director of the company and a director of Associated Electrical Industries Ltd. Mr. Ball is also chairman of the British Thomson-Houston Export Co. Ltd., the British Thomson-Houston Co. (South Africa) (Pty.) Ltd. and the British Thomson-Houston Co. Central Africa (Pty.) Ltd., the British Thomson-Houston Co. (Canada) Ltd., A.E.I. Lamp & Lighting Co., and of Birlec Ltd.

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Danfoss Manufacturing Co., 13, Queensway, London, W.2, inform us that they have recently introduced the Danfoss AT Clip-on Thermostat which will meet an urgent need in the heating industry for an instrument which, besides being efficient and of low cost, is particularly simple to install. Having a breaking capacity of 6 amps a.c. with change-over contacts, it will find a wide range of application for the control of oil-burners, motorised valves, dampers, etc. Delivery is ex stock, and we understand that literature will be available shortly.

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Mr. L. H. Cooper, chairman of The Mond Nickel Company Limited and vice-president of The International Nickel Company of Canada Limited, has been elected a director of that company.

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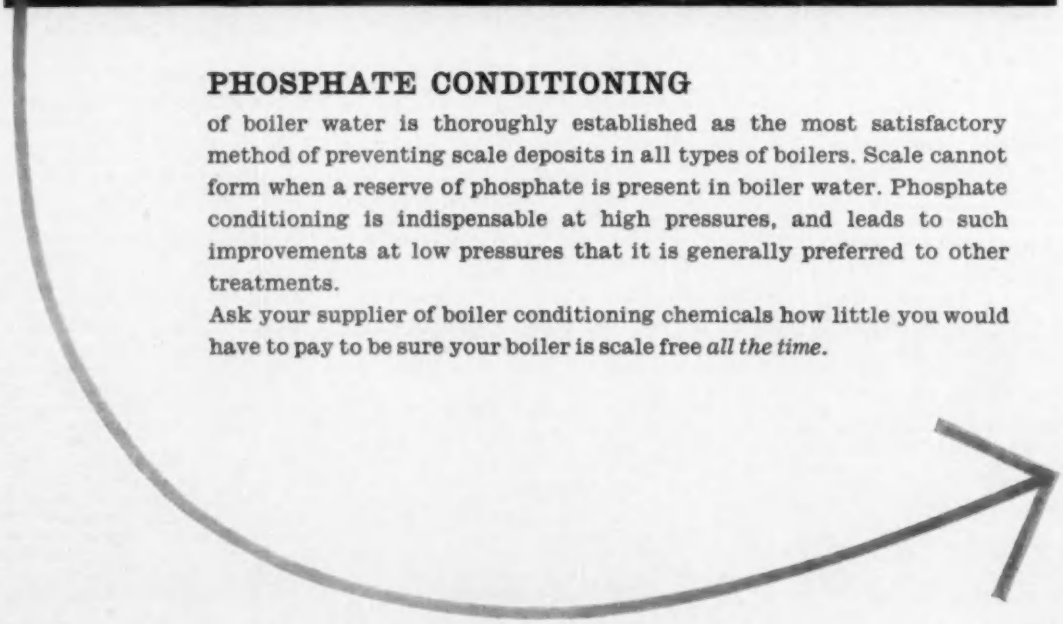

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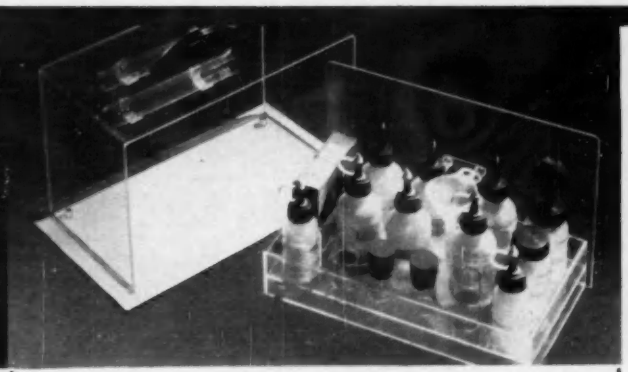

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OVERSEAS Steam Engineering Practice

Abridgments of recent articles in the colonial and foreign technical press, concerning design and progress in the technique of steam generation and power plant equipment

Automatic disposal of fly-ash

A completely automatic fly-ash disposal system has been incorporated in the new 180-MW, E. F. Barrett power station of the Long Island Lighting Co. of America. This comprises first-stage cyclone-collectors and second-stage electrostatic-precipitators, which together are capable of handling up to 518,000 cu. ft./min. of flue-gas from the 1,150,000 lb./hr. boiler, with a dust-collection efficiency that is claimed to be over 95 per cent. The entire system is controlled by a master switch which is either positioned at "automatic" when the hoppers empty in a predetermined order, or at "by-pass" which initiates the same sequence until the switch is positioned at "manual" when the hopper to be emptied can be selected individually. The central control panel, in addition to the master switch also has "on-off" switches for the pumps supplying water to a vacuum-producer (for conveying both fly-ash and furnace-ash), and instruments showing water-pressure, vacuum (in. Hg.), and pump-motor amperage. The vacuum-producer is a vertical venturi, ringed internally with downward-directed water nozzles. Vacuum created by high-velocity jets from these nozzles, pulls the ash through the hopper outlet valves, the water and ash discharging into an air-separator tank, then flowing by gravity to the disposal areas. Vacuum is held at about 20-in. Hg. during hopper discharge, and drops to about 5-in. Hg. when the hopper empties, at which point the sequence control automatically closes the empty hopper valve, waits for the vacuum to build up again, and then opens the next hopper valve. The first-stage dust-collector is made up of 4 per cent. cyclones in two parallel banks, each bank being sub-divided into six groups of four cylinders which discharge into 280 cu. ft. capacity hoppers. A separate split-duct manifold supplies each group, providing for tangential entry without a gas-pressure drop due to direction change. Cleaned gas rises at the centre of the cyclone, leaving through an outlet at the top. A rectangular port in the upper part of the collector raises efficiency by eliminating the fines which tend to build-up in eddy currents at this spot. The fines by-pass the normal particle flow, and travel directly to the main body of dust in the conical section of the collector. From the cyclones, the gas stream, which still contains extremely fine dust, passes to electrostatic precipitators, each having two independent 36-pass sections, which handle the gas from one bank of cyclone collectors. Dust collected by the precipitators is stored in hoppers until disposed of by the hydraulic method and in the manner already described. (*Power*, Vol. 102, No. 1, pp. 90/91.)

New power station equipment and plant arrangement

The capacity of the first of six units to be constructed at the new Portland power station of the Metropolitan Edison Co. will be approximately 165-MW, and the station will be unique in that it will combine a subcritical-pressure Monotube steam generator, a close-coupled cross-component axial exhaust turbine and side-entry condenser, and a system of direct energy-balance combustion control. Other distinguishing, but less significant features, will be welded condenser tubes; all-welded high-pressure heaters; small bunkers and automatic coal-handling system; floating high-pressure de-aerating heater; high-speed boiler feed-pumps; and two-level pressure operation. The steam-generating unit is conservatively designed to deliver 1,150,000 lb./hr. at 2,610 lb./sq. in., 1,060 deg. F. superheat, and 1,060 deg. F. reheat with a furnace heat release of 89,000 B.Th.U./sq. ft. of effective projected radiant surface. This Monotube steam generator has several unusual characteristics. There are no large heavy-walled drums or downcomers, but there are three pressure vessels—two water-separators and a by-pass separator. The water and steam side of the Monotube unit is divided into two halves each having separate controls. In the steam-generating section of the unit each half is divided into six circuits, the flow to each of these being controlled by a special sleeve-type throttling valve. Each half has its own water-separator located between the evaporating section and the primary superheater. Solids are concentrated in the water-separator, and approximately 4 per cent. of the total flow is bled back into the cycle through the water-to-water heat-exchanger. The water flow to the unit is controlled by two pressure-difference regulating valves and two flow-regulating valves. The flow-regulating valves take their impulse from a thermostat located on the outlet of the steam-generating tubes and from a steam-flow orifice located after the water separator. Any one tube in each circuit can be designated as a control tube since all tubes have a throttling valve at the inlet and a thermostat at the outlet. Only one tube in each circuit is used at a time for control, and the throttling valves are adjusted so as to provide steam to this tube with 50 deg. F. superheat, while the remainder of the generating tubes in the circuit produce steam with 4 per cent. moisture. Steam-temperature control is similar to that for conventional units with a combination of tilting burners and spray desuperheaters. Advantage is taken of radiant superheaters to give a flat temperature control over a wide range of steam flow. The turbo-alternator for the Portland No. 1 unit will be the first large close-coupled cross-compound axial-flow exhaust turbine supplied by the General Electric Company. The low-pressure turbine will be a single-cylinder unit and will have the same centre line as the condenser. The choice of condenser design for use with the axial-flow exhaust turbine was most important if the expected improvement in cycle efficiency is to be achieved. To accomplish this, Ingersoll-Rand, who were responsible for the design, and who will construct the plant, collaborated with the turbine manufacturer and conducted a series of tests to establish the optimum shape of the turbine-condenser connecting piece. The condenser itself is of the single-pass type with a divided water-box, and having

80,000 sq. ft. of surface. Condenser leakage cannot be tolerated because of the feedwater purity required by the Monotube steam generator. To minimise the possibility of leakage, the manufacturer is welding the tubes in the tube sheet utilizing a new process. Tubes are admiralty metal and tube sheets silicon bronze—two materials that tests have shown to be readily weldable. Two basic methods are being provided for combustion control ; (a) the direct energy-balance method, and (b) the so-called conventional method. Selection may be made from one to the other by transfer switch, but it is expected that the direct energy-balance method will normally be used. With this method, the input of fuel to the furnace is directly regulated by the unbalance between the required output and the actual generator output, the air by generator output, and the turbine governor controlled to maintain steam pressure. Energy input to the furnace is directly controlled to give the desired generator output, and the turbine keeps in step with the steam-generator output. With the conventional method the steam output follows the turbine demand. (*Combustion*, Vol. 29, No. 7, pp. 34-41.)

The Scientific Instrument Manufacturers Association of Great Britain (SIMA) has booked floor space covering some 5,000 sq. ft. at the second Atoms for Peace Exhibition to be held in September, 1958, at Geneva. This move, backed by 25 member firms of the Association, is symptomatic of the nucleonic instrument industry's keen endeavour to demonstrate the pre-eminent and dominant position it occupies. Britain is ahead of the world in nucleonic instrumentation and controls, and this major exhibit will, it is stated, demonstrate this fact in no uncertain terms, and indicate how the industry is rising to the challenge of European Free Trade. The Association has appointed Industrial Exhibitions Limited to be its organising and co-ordinating authority for this participation which forms a large part of the overall British nuclear engineering display being arranged by the Nuclear Energy Trade Association's Conference (NETAC) of which SIMA is a founder member. The SIMA exhibit will consist of a large central enquiry and general display stand surrounded by the individual stands of British atomic instrument and control equipment manufacturers.

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A new illustrated folder (publication No. 72) available from **W. C. Holmes & Co. Ltd.**, P.O. Box No. B.7, Turnbridge, Huddersfield, describes briefly the range of dust collection and control plant manufactured by the company's gas cleaning division. The equipment comprises four distinct types of plant, with applications covering the majority of industrial air pollution problems, and includes the Holmes-Elex electrical precipitators ; the Holmes-Schneible multi-wash system ; the Holmes-Rothemuhle multi-cell cyclone dust collectors ; and Trion electronic air filters.

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The rapid expansion of the company's activities overseas has made it necessary for **Eversheds & Vignoles Limited** to open a branch office in Belgium. This office, to be opened on April 1st, 1958, will be under the management of **Mr. C. Samyn** who has for a number of years handled the company's products in Belgium. The whole range of electrical instruments, instrumentation and control equipment, will be made available through this office for the following countries : Belgium, Belgian Congo and the Grand Duchy of Luxemburg. The address of this new office is:—Eversheds & Vignoles Limited, Succursale, 142, Rue Gallait, Brussels.

Mr. K. Druce, D.F.H., A.M.I.E.E., has been appointed manager of the Bristol office of The English Electric Company, responsible for the south-west of England territory, in succession to Mr. T. Robinson, who retired on December 31st, 1957. From 1946, Mr. Druce was in the " English Electric " switchgear department at Stafford, and during the past eight years, has been in the London office, where he came in close contact with the Admiralty, with whom he will continue to liaise on behalf of the company. Following the retirement of Mr. I. Mackintosh, also on December 31st, 1957, **Mr. H. Granville-Brown,** A.I.E.E., has taken charge of the Southampton office of The English Electric Company, which has moved to new premises at 29, Shirley Road, Southampton. (Telephone No. : Southampton 28333/3.) Mr. Granville-Brown joined The English Electric Company in 1947 and was appointed to the Southampton office.

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Four apprentices of **Metropolitan-Vickers Electrical Co. Ltd.** were among those who represented Britain in an international trade competition which was held recently in Madrid. They were chosen from eight candidates nominated by the company at the request of the City and Guilds of London Institute, and in their respective trades were awarded one second and two third prizes. The international trade competition, which was started in 1950 under the auspices of the National Headquarters of the Spanish Youth Organisation and the Portuguese Juvenile Organisation " Mocidade Portuguesa," is run by an organising committee consisting of representatives from each of the competing countries. Since 1950 the competition has been held in Spain, but it is likely that in the future it will be held in a different country each year.

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A new brochure entitled " Bestobell Packings," issued by **Bell's Asbestos and Engineering Ltd.,** Bestobell Works, Slough, Bucks., deals generally with the company's products, and contains a comprehensive guide to packing selection.

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Mr. L. E. Nichols has resigned as N.I.F.E.S. area engineer in the north-east, and is proposing to re-enter consulting engineering practice. For the time being, Mr. George Gill, area engineer in the north-west, will also be exercising general supervision over the Leeds, Sheffield and Newcastle offices.

In order to concentrate under one director, all matters relating to the steering-gear division of George Kent Ltd., **Mr. L. A. C. Bartlett,** A.M.I.Mech.E., has undertaken the over-all supervision of this section of the company's activities, and is relinquishing his duties as commercial director of the instrument division. As a result of this change and to give closer liaison between the Sales and the Research and Development Organisation, **Mr. R. S. Medlock,** B.Sc., A.R.I.C., A.M.I.Mech.E., A.M.I.E.E., has been appointed as technical and home sales director. He assumes responsibility for the contracts department, home sales representatives, and service and erection, in addition to his duties as director in charge of research and development. A central organisation has now been established in Australia under the direction of **Mr. F. E. Cook,** M.Inst.F., whose position as home sales manager is being taken over by Mr. J. Tham.

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Birlec Ltd., Tyburn Road, Erdington, Birmingham, 24, inform us that they have received orders for absorption dryers from Sunvic Controls Ltd., to provide dry air to the control instruments at the Berkeley nuclear power station, and from the Nuclear Power Plant Co. Ltd., to dry compressed air for testing reactor vessels at the Bradwell nuclear power station. Drying equipment is also being supplied to the Fawley refinery of the Esso Petroleum Co. Ltd. In connection with their recently developed mains-frequency coreless induction melting furnace, Birlec say that the number ordered or installed is now over thirty.

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A new single-page leaflet (N.V.240) has been published by **Lancashire Dynamo Nevelin Ltd.,** Oxted, Surrey, under the title " Direct-to-Mains Varionic variable speed drives." The equipment is designed for direct connection to 3-phase a.c. mains, and eliminating the need for a rectifier transformer.

* * *

James Gordon & Co. Ltd., announce that **Mr. R. Sosbe** has been appointed as their representative in Lancashire, Cheshire and North Wales, his address being :—24, Hambleton Road, Heald Green, Cheadle, Cheshire.

* * *

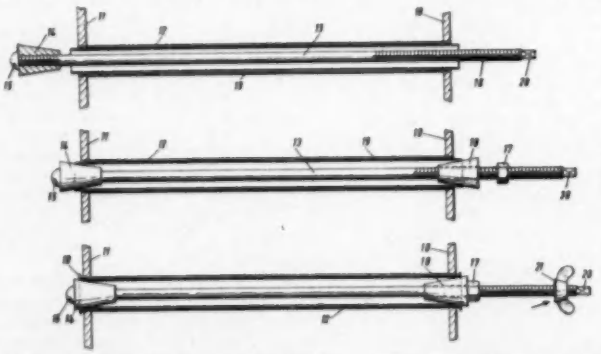
Wakefield-Dick Industrial Oils Ltd. announce the appointment of **Mr. J. W. MacMahon** as general manager of their Industrial Lubricants Division in succession to **Mr. R. J. Turner** who has retired. Mr. MacMahon is also appointed to the board of directors of the company.

Latest Power Plant Patents

These extracts from British Patent Specifications are reproduced by permission of The Controller of H.M. Stationery Office. (Complete British Specifications can be obtained from the Patent Office, 26, Southampton Buildings, London, W.C.2. Price 3s. 6d. each, both inland and abroad.)

Sealing defective boiler tubes

This invention relates to devices for stopping or sealing a defective boiler tube. Figs. 1A, B, and C show a boiler front tube plate (10) and a back end tube plate (11). Between these two plates extends the boiler tube (12) which it is assumed has fractured and become defective. The sealing or isolating device for the defective tube (12) comprises a stay or rod (13), having a cone (14) at the rear end. This cone is screwed on to the end of the rod which is then riveted over as indicated at (15). The opposite end of the stay (13) is screw-threaded as indicated at (16) to receive a nut (17). On the screw threaded part (16) in front of the nut is a further movable cone (18). The stay (13) passes through a stopper or sealing tube (19) having a diameter slightly less than the internal diameter of the defective tube. The maximum diameter of the cone (14) is also slightly less than the internal diameter of the tube (12) so that it will slide freely through the defective boiler tube. In using the device, the stay (13) together with the fixed cone (14) is slid through the defective boiler tube until the cone is felt to slide off the tube at the back end of the boiler. The stopper tube (19) is then slid into the defective tube over the stay (13) so that the stopper tube projects or overlaps say half an inch beyond the back plate (11) and the front plate (10). The movable cone (18) is then slid along the front end of the stay (13) until it enters the stopper tube (19). The nut (17) is then screwed on to the stay and tightened up so as to draw the cone (14) into the back end of the stopper tube and force the cone (18) into its front end. As a result the ends of the stopper tube are expanded and make a metal to metal fluid-type joint against the front plate (10) and back plate (11), and around the defective tube. Thus the defective tube is effectively sealed and isolated. *British Patent No. 788,505 issued to W. G. Smith. Complete specification published January 2nd, 1958.*



(Left). Figs. 1A, 1B and 1C. British Patent No. 788,505.

Improved superheater or reheater installation

The superheater or reheater tubes shown diagrammatically in Figs. 2 and 3, and which are suspended inside a boiler are of U-shape, the bend of each tube being located at the lower end. Each tube is provided at its lower end with a tubulure (b) which opens into a drainage collector tube (c) common to all the tubulures of the row of tubes. By the term "tubulure" is meant a short tube of small bore which is formed in the wall of a larger tube in such a manner that the wall of the short tube is integral with the wall of the larger tube, as distinct from an arrangement in which a short pipe is joined, for example, by welding to the wall of a suitably orificed large tube so that the inside of the pipe communicates with the inside of the large tube through the orifice. The collector tube (c) is provided with a drain hole (d) and provides a means by which liquid condensed in the tubes (a) can be drained. The bend of each tube (a) is preferably located below the chain-line *X-X* which represents diagrammatically the lowest extent of the flow of the heating gases, so that the lowest portion of each tube (a) and the drainage collector tube (c) are removed from the heating action of the gases. The drainage collector tube (c) also serves as a cross-brace for the lower end of each tube (a)

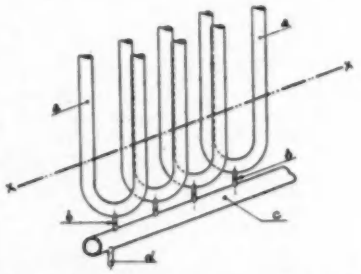
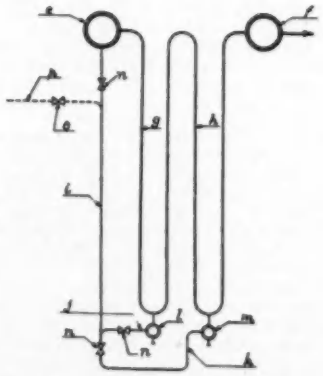


Fig. 2 (above). Fig. 3 (below). British Patent No. 788,704.



so that maintenance of the correct positions of the tubes (a) is ensured, while at the same time downward expansion of the tubes (a) is allowed. As shown in Fig. 3 the installation circuit comprises two rows of tubes, each similar to tubes (a), designated (g and h), each of which is connected to a drainage collector-tube (l) and (m) respectively. The inlet end of each tube in the row (g) opens into a common inlet header (e) and the outlet end of each tube in the row (h) opens into a common outlet header (f). Connecting the inlet header (e) with each of the drainage collector

tubes (l) and (m) is a by-pass circuit comprising pipe (i) and valve (n) by which the circuit can be opened or closed to allow or prevent the passage of the steam from the inlet header (e) to the drainage collector tubes (l and m). Thus, some of the steam entering the header (e) can be allowed to by-pass one or both of the rows (g and h) of tubes before reaching the outlet header (f), thereby lowering the temperature of the steam leaving the installation. If desired, the pipe (i) can be connected by pipe (p) containing the valve (o) to a water supply so that the temperature of the steam leaving the installation can be optionally further lowered by introducing water into the inlet header (e) or either or both of the drainage collector tube (l and m). The operation of valves (n) and/or (o) may be automatic and responsive to the temperature of the steam leaving the installation. *British Patent No.* 788,704, *issued to A. Huet. Complete specification published January 8th,* 1958.

Improved liquid sodium circuit

Systems in which liquid sodium, sodium/potassium alloy or other liquid metals are circulated as a heat-exchange medium may be cleaned, after complete removal of the metal, by passing through them a cleaning fluid, such as liquid ammonia. For

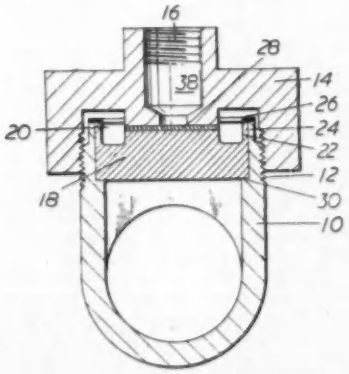


Fig. 4. British Patent No. 788,751.

controlling the flow of such cleaning fluids into and around the various parts of the circuit, simple flow-control valves of the type having a spindle projecting through a packed gland in an internally threaded nut on the valve housing are quite satisfactory. Such valves are, however, generally unsuitable for use in contact with liquid metal because of the danger of leakage through the packing, and relatively expensive bellows-sealed valves have to be used for handling these materials. Referring to Figs. 4 and 5, the system is provided, at a point convenient for the circulation of a cleaning fluid, with a permanent cylindrical packed valve housing (10) having an external thread (12) at its upper end to which can be screwed a nut (14) provided with the usual packed gland aperture (16). When the system is in use as a heat-exchanger and charged with liquid metal, it is generally impracticable to incorporate a packed valve because leak-tightness is usually of prime importance. The temporary valve assembly shown in Fig. 4 is

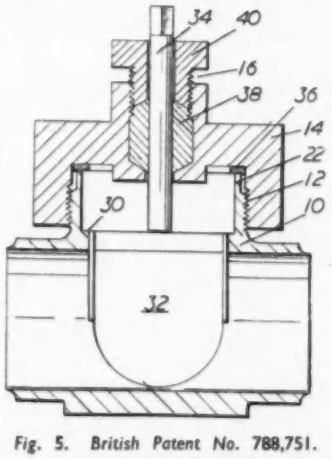


Fig. 5. British Patent No. 788,751.

accordingly removed and a suitable plug (18) inserted into the top of the housing to close the spindle opening during normal operation of the system. The plug is angularly grooved at (20) to form a tongue (22) which abuts a similar tongue (24) on the housing (10) to which it is sealed by welding around the upper edges at (26). The plug (18) is held down firmly by means of the nut (14). A circular gasket (28) is placed between the plug and the nut. The plug rests on a shoulder (30) on the inner face of the housing (10). When the circuit is to be cleaned a valve is required. The plug (18) is, therefore, removed, for example, by grinding away the weld (26), and a butterfly valve (32) is set in the housing (10) with its spindle (34) passing through the nut (14), fitted with the usual annular gasket (36), and screwed down on to the housing (10). The gland space (38) is packed in the usual way and closed by a plug (40). After cleaning, the valve assembly is removed and the plug (18) is replaced for the resumption of normal operation. *British Patent No.* 788,751 *issued to Foster Wheeler Limited. Complete specification published January 8th,* 1958.

Forced-circulation steam generator

This invention relates to forced and controlled-recirculation steam generators, and is particularly applicable to large high-pressure units. In forced and controlled steam generators of the recirculation-type the working medium is circulated through the heating surface in quantities in excess of the evaporation, use being made of a circulating-pump which withdraws water from a steam and water drum and delivers it at a somewhat higher pressure to the heated boiler tubes which are arranged in parallel between distributor-headers and collector-headers or between distributor-headers and the steam-drum. It is customary in this type of steam generator to instal orifices at the inlet of each of the evaporating tubes in order to equalise the flow in the many tubes in parallel. A pressure drop in addition to the frictional pressure drop caused by the flow of the working medium in the heating tubes is thus provided. This reduces the influence of pressure drop variations in the evaporating tubes which may occur

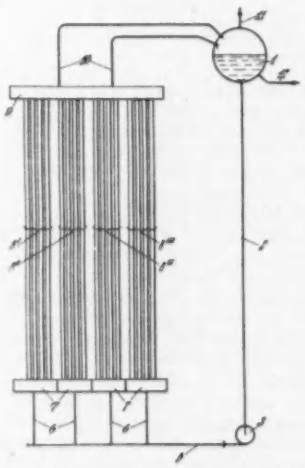
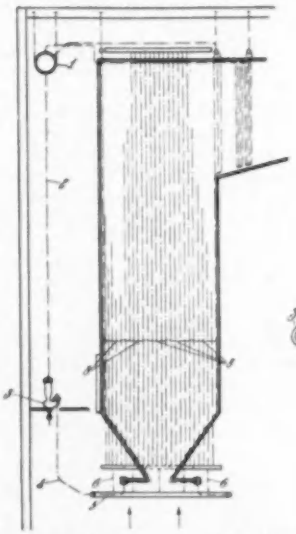


Fig. 6. British Patent No. 789,431.

in consequence of uneven heat absorption by some of the tubes. In large power station steam generators having an evaporation in the region of 1,000,000 lb./hr. and more the combustion chambers have a square or rectangular cross-section and are of considerable height. The four vertical walls are lined with tangent tubes extending vertically between distribution headers and the steam drum. There are a large number of tubes arranged for flow in parallel and it is the object of this invention to replace the number of orifices hitherto used, by different means of

controlling the water supply to the tubes. The evaporating tubes emanating from the distributor headers are divided into separate groups, and proportioning tubes supply water to each group from the pump discharge pipe. Referring to Fig. 6, from a steam and water drum (1) water is withdrawn by circulating pump (3)



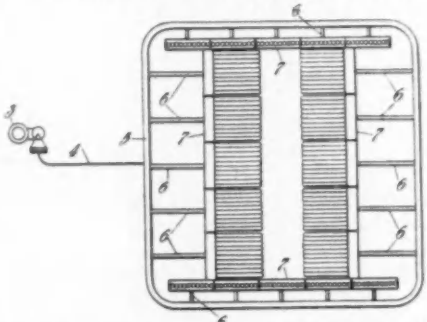


Fig. 7 (extreme left). Fig. 8 (left). British Patent No. 789,431.

by way of pipe (2) and discharged into pipe (5) which is connected to a number of distributor headers (7) by proportioning tubes (6). Groups of evaporating tubes (8′, 8″, 8‴ and 8⁗) emanate from the headers (7) and the steam generated in tubes (8) is discharged, together with the remaining water into a collector header (9) from where the steam and water mixture is conducted via pipes (10) to the steam and water drum (1) in which the generated steam is separated from the water. The steam is taken from the drum through a pipe connection (11) for use, after passing through a superheater which is not shown. On returning to the drum the water circulated in excess of the boiler evaporation mixes with feedwater supplied at (12), and is recirculated in the system. The evaporation in each tube of a group will be practically equal, and therefore the frictional pressure drop in all the tubes of one group will be substantially the same. However, it is possible that the evaporation of one group of tubes may differ to a certain if only small degree from another group of tubes. If for instance the tubes of group (8⁗) absorb more heat than the tubes of group (8′), the frictional resistance in them will be higher than in the tubes of group (8′). This would result in less water flowing through the tubes in group (8⁗) and in more water flowing through the tubes of group (8′) unless the additional pressure drop in the tubes (6) is made high enough to reduce and render negligible the influence of pressure drop variations between groups of tubes. Fig. 7 shows the combustion chamber of a large high-pressure steam generator in vertical section, and Fig. 8 is a plan view in the direction of the arrows in Fig. 7. From the drum (1) boiler water flows through pipe (2) to the circulating-pump (3) which discharges the water via pipe (4) to the ring-pipe (5). This ring-pipe is connected with the headers (7) by the proportioning tubes (6). The headers are divided into a suitable number of sections, from which the evaporating tubes emanate, so that groups of tubes (8) are formed, each group being supplied separately with the requisite amount of water. *British Patent No.* 789,431 *issued to La Mont International Association Ltd. Complete specification published January* 22*nd*, 1958.

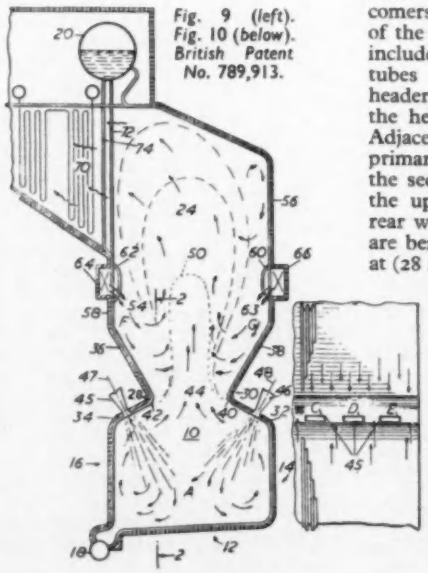


Fig. 9 (left). Fig. 10 (below). British Patent No. 789,913.

Boiler furnace

This invention relates to a boiler for high-pressure and high steam temperature, fired with a slag-forming fuel. Advantages may be gained in such a unit by effecting combustion of the fuel at temperatures above the fusion temperature of the incombustible matter in the fuel. When combustion is effected at such high temperatures, however, cooling means must be provided in order to avoid overheating of the convection heating surfaces of the superheater, and deposition of slag in sticky form on these surfaces. The requisite tempering can be effected by radiant-heat transfer, but this necessitates a large area of radiant cooling surfaces. Using this invention, tempering of the fresh furnace gases is effected in a manner involving the recirculation of gases of reduced temperature to a gas mixing zone between a combustion zone and the convection surfaces. The boiler illustrated in Fig. 9 includes a high-temperature combustion-zone in a primary, slag-tap furnace chamber (10) having a floor (12) provided with an opening (not shown) for the removal of molten slag, and front and rear walls (14 and 16), including steam generating tubes lining the front and rear walls of a secondary furnace chamber (24) and appropriately connected to a water and steam drum (20). The water-space of the drum is directly connected to the header (18) by downcomers (not shown). The side walls of the primary furnace chamber (24) include upright steam generating tubes (not shown) connected by headers and tubular connections to the header (18) and the drum (20). Adjacent to the junction of the primary furnace chamber (10) and the secondary furnace chamber (24), the upright tubes of the front and rear walls of these furnace chambers are bent inwardly to form the arches at (28 and 30). The primary furnace chamber (10) and the secondary furnace chamber (24) are rectangular in cross-section. At opposite sides of the primary furnace chamber (24) are rectangular rows of pulverised-fuel burners (45 and 46), the centre lines of which are downwardly convergent as indicated at (47 and 48). The combustion gases containing those fused particles of incombustible matter which are not deposited on the floor,

but which remain in suspension, pass upwards along the walls (14 and 16), and between successive burners which are spaced as indicated at (C, D and E) in Fig. 10. The inclined arch walls (32 and 34) turn the upward gas flow inwards towards the centre of the restrcted throat (44) between the arch noses (40 and 42), and the flow of gases continues in a high velocity jet (50). This is centrally located in the secondary furnace chamber (24), forming a secondary heat-exchange zone in which heat is transmitted by radiation from the products of combustion serving for the evaporation of water in the wall tubes of chamber (24). The high velocity jet exerts an eductive action creating relatively low-pressure zones at opposite sides. Thus, recirculated gas zones (F and G) are formed on opposite sides of the high velocity gas flow in the jet (50). The natural circulation tendency in these zones is utilised to assist the downward entry of recirculated lower temperature combustion gases into the zones (F and G), as indicated by the arrows (54 and 63). Entry ports for the recirculated gases are provided by the bending of some of the tubes along the front and rear walls (56 and 58) of the secondary furnace chamber (24) as indicated at (60 and 62). There are rows of recirculated gas ports along the rear wall (58) and the front wall (56) respectively, the arrangement being such that recirculated gases are delivered along the whole lengths of the wall portions (36 and 38). Recirculated gases are conducted to these ports by appropriate ductwork, the outlets of which are indicated at (64 and 66). This ductwork has inlets communicating with combustion gas flow beyond a convection superheater (70), and an appropriate fan (not shown) is provided for causing the flow of recirculated gases. *British Patent No. 789,913 issued to Babcock & Wilcox Ltd. Complete specification published January 29th, 1958.*

Versil Ltd., Rayner Mills, Liversedge, Yorkshire, have published a new brochure entitled " Versil Glass Fibre Thermal Insulation." The brochure describes the application of Versil glass fibre for various applications in the power plant and steam generating industry and numerous illustrations of Versil insulated plant are included. Versil consists of a profusion of fine, long continuously drawn glass fibres of predetermined diameter, processed from glass of known characteristics. These silk-like fibres possess highly polished surfaces and when built-up by layers into a homogeneous mass, enclose an infinite number of sealed air cells. Thus, the two essential properties of an efficient thermal insulating material are found together in Versil. Glass fibre is unaffected by temperatures up to 1,000 deg. F. and withstands fluctuations of temperature without disintegrating. It is very light (a cubic foot weighing only 9 lb.); withstands continuous vibration; is chemically inert, non-inflammable and non-corrosive under all conditions of moisture or temperature.

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The Electricity Council announce the following appointments :— **Mr. John A. Wedgwood,** M.A., A.C.I.S., as deputy secretary ; **Mr. David Moffat,** M.B.E., as chairman of the superannuation schemes and for special duties ; **Mr. C. A. French,** A.S.A.A., A.I.M.T.A., and **Mr. Frank A. Rawlings,** O.B.E., F.R.Econ.S., as deputies to the financial adviser ; **Mr. R. Y. Sanders,** F.S.S., F.R.Econ.S., as deputy commercial and development adviser ; **Mr. R. D. V. Roberts,** B.Com.(Lond.), as a deputy to the industrial relations adviser ; **Mr. L. H. Kent,** B.A., B.C.L., as deputy legal adviser ; **Mr. W. J. Hendry** as public relations officer.

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Elliott Brothers (London) Limited announce that **Mr. George C. Fairbanks,** M.I.P.E., a deputy general manager of the company, has been appointed a director. Mr. Fairbanks joined Elliott Brothers in 1930 as a tool-maker. In 1933 he became superviser of the Admiralty Gyro Department, and received further promotions, until, by the end of the 1939-45 war, he was shops superintendent at the company's Lewisham works.

The United Kingdom Atomic Energy Authority have appointed **Dr. H. Kronberger,** O.B.E., F.Inst.P., to be Director of Research and Development in the Authority's Industrial Group. Dr. Kronberger succeeds **Mr. L. Rotherham,** M.Sc., M.Inst.Met., whose appointment as a member of the Central Electricity Generating Board was recently announced. Dr. Kronberger went to Harwell in 1946, shortly after the Establishment was formed and worked in the general physics division under D. W. Fry. In 1951 he joined the Capenhurst Laboratories of the Industrial Group and subsequently became Head of Laboratories where he was primarily responsible for the development of diffusion plants for the separation of uranium isotopes. He was appointed chief physicist at Risley in 1956, and was awarded an O.B.E. in 1957.

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Mr. William Thomas Bell, O.B.E., J.P., M.I.Mech.E., who died on January 27th at the age of 90, was chairman and joint managing director of Robey & Co. Ltd., Lincoln, and had been actively engaged with the company for 73 years up to the day of his death. Mr. Bell was apprenticed to Robey's in 1885, appointed secretary in 1893, director in 1905, managing director in 1914, and chairman and managing director in 1922.

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We are informed that the Nottingham area sales office of **Lancashire Dynamo Group Sales Ltd.** is now at 2, St. James's Terrace, Standard Hill, Nottingham (telephone : Nottingham 43025/6).

* * *

Mr. W. H. Apthorpe, M.I.E.E., managing director of the Cambridge Instrument Co. Ltd., retired from executive duties a few weeks ago. He is retaining his seat on the Board, and will continue to be available for special duties as deputy chairman. Mr. Apthorpe was appointed a director of the company in 1925 and has since held in succession the position of director of production, joint managing director, and, finally, managing director. He is succeeded as managing director by Mr. **H. C. Pritchard,** B.A., F.R.Ae.S., who has had a distinguished scientific and administrative career, and until recently held a senior position with Elliott Bros. (London) Ltd.

Mr. E. Pearson has been appointed assistant sales manager of Fielden Electronics Limited. Mr. Pearson has been with the company for a number of years, and before his promotion he combined the duties of textiles instrument division manager with that of north-west area sales supervisor. He is now responsible for all internal and external staff associated with the sales department. **Mr. G. Ensor,** general manager of the company, has now resumed the office of sales manager in addition to his other duties.

* * *

Mr. W. J. W. Procter, sales director, Follsain-Wycliffe Foundries Limited, is now visiting Johannesburg and district, after which he will make a comprehensive tour of North—and South—Rhodesia with the object of carrying out a sales survey, and in order to appoint agents to handle the firm's heat and abrasion-resisting castings, their Pulmac pulverising mills, and also variable-speed gear-boxes and speed reducers manufactured by their subsidiary company, Varatio-Strateline Gears Limited.

* * *

Mr. J. Strong, a director of the British Oxygen Company, has relinquished his appointment as chairman of Quasi-Arc Ltd., on being appointed chief executive director of British Oxygen Gases Ltd.

* * *

Crompton Parkinson Ltd. has secured, in the face of strong competition from some 12 other manufacturers, six of them in America, and the others in Austria, Italy and Switzerland, as well as Britain, an order from the United States for six power transformers valued at upwards of $200,000. The transformers are each 8,687-kVA, single-phase for 115-kV service voltage and are to be employed in the Fremont Canyon Power Project in Wyoming. The transformers will be built at the company's B.E.T. transformer works at Hayes, Middlesex, during the next 16 months.

* * *

The Pulsometer Engineering Co. Ltd. states that its associate, the Self-Priming Pump and Engineering Co. Ltd., Slough, is to be known in future as S.P.E. Co. Ltd. The London office of this company is now at 20-26, Lamb's Conduit Street, W.C.1.

NOTES Personal AND Industrial

Mr. J. C. Duckworth, B.A., F.Inst.P., A.M.I.E.E., deputy chief engineer (nuclear power), has been appointed chief research and development officer of the Central Electricity Generating Board. In 1947, Mr. Duckworth went to the Atomic Energy Research Establishment at Harwell, where he supervised a group working on neutron spectroscopy involving measurements work concerning nuclear reactors. He became chief engineer of the Ferranti Laboratories, Wythenshawe, in 1950, and in 1954, was appointed nuclear power engineer with the Central Electricity Authority, subsequently becoming deputy chief engineer (nuclear power) in January 1957.

* * *

G. & J. Weir Ltd., Cathcart, Glasgow, announce the appointment of **Dr. R. S. Silver,** M.I.Mech.E., F.I.P., as general m nager of their technical division. Dr. Silver was head of Weir's research department from 1939 to 1946. He then resigned and took up other positions in which he gained considerable experience in the fields of steam and combustion engineering where he held important appointments, being responsible for the design of large steam generating plant and for major developments in evaporating plant design. He returned to G. & J. Weir Ltd. in 1956.

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Mr. J. L. Harrison has been appointed technical sales manager of Davy British Oxygen Limited, and **Mr. K. T. Brightman** has been appointed assistant technical sales manager.

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The Lancashire Dynamo Group announce that **Mr. A. J. Beanland,** B.Sc.(Tech.), M.I.E.E., etc., has been appointed group sales director. Mr. Beanland, who will be a director of Lancashire Dynamo Group Sales Ltd., will be in charge of the L.D. group sales organisation at home and overseas. After holding various engineering appointments with Lancashire Dynamo & Crypto he became their branch manager at Leeds in 1945, manager of the Cardiff fractional h.p. motor factory in 1949, and subsequently director and general manager at the Trafford Park Works. He takes up his new appointment on March 1st.

* * *

Mr. A. D. Bailey, A.M.I.Mech.E., A.M.I.E.E., manager of Brook Motors Ltd., sales office at Newcastle for the last 4½ years, has been appointed manager of the company's Birmingham office. At Newcastle, **Mr. H. hoothroyd,** formerly sales engineer, is now manager. **Mr. R. Sugden,** sales engineer at Norwich, now moves to a similar position at Newcastle.

* * *

After 45 years service with the British Thomson-Houston Company at its Rugby and Willesden Works, **Mr. N. Devonald,** B.Eng.(Hons.), A.M.I.E.E., of switchgear contracts, Willesden, retired in January.

Mr. Donald Clark, B.Sc.(Eng.), A.M.I.E.E., A.C.G.I., station planning and development engineer has been appointed chief planning engineer for the Central Electricity Generating Board. In 1941, Mr. Clark was appointed assistant, later chief assistant, to the station development engineer of the Central Electricity Board. With the reorganisation of the electricity supply industry in 1948, he was appointed station development engineer at the headquarters of the former British Electricity Authority, and later became station planning development engineer. He has had particular responsibility for the planning and siting of the major power stations embarked upon in recent years, notably the several large thermal power stations now being built on the river Trent near the East Midlands coalfield, and more recently for the nuclear power stations.

* * *

Ruston & Hornsby Ltd. announce the appointment of **Mr. Herbert E. Reynolds** as manager of their Bristol office. He succeeds **Mr. C. W. Hudson** who retired at the end of last year after more than 50 years with the company. After war service Mr. Reynolds returned to Ruston & Hornsby as technical representative at their London office, and from there went to Bristol as assistant manager at the beginning of 1955.

* * *

Metropolitan-Vickers Electrical Co. Ltd., announces the appointment of **Mr. A. O. Ahlquist,** M.A., A.M.I.Mech.E., as sales manager, mechanical department. Mr. Ahlquist succeeds **Mr. H. Lawson-Jones,** who will act in an advisory capacity, and who is transferred to sales management. In 1951, Mr. Ahlquist was appointed assistant to sales manager (large turbines), mechanical department, and he became assistant sales manager, mechanical department, in January, 1957.

* * *

Megator Pumps & Compressors Ltd. (43, Berkeley Square, London, W.1), announce that **Mr. A. Billingham,** their technical representative in the Midlands, will shortly be taking up an appointment with Megator Pumps & Compressors Inc., Pittsburgh, U.S.A., the newly-formed subsidiary which handles their American business. Mr. Billingham is succeeded in the Midlands by **Mr. N. H. Macpherson,** of 72, Wombourn Park, Wombourn, Wolverhampton.

* * *

Kelvin & Hughes (Industrial) Ltd., has appointed **Mr. V. P. Scholes** as area representative for the Midlands.

* * *

Lord Citrine has been appointed by the Prime Minister as a part-time member of the United Kingdom Atomic Energy Authority in succession to Sir Luke Fawcett.

The following new appointments have been made by the United Kingdom Atomic Energy Authority. **Mr. J. C. C. Stewart,** formerly director of technical policy in the Industrial Group at Risley, becomes a deputy managing director of the Industrial Group ; **Mr. J. B. W. Cunningham,** formerly deputy director (civil reactors), becomes director of Industrial Power in the Industrial Group ; **Dr. R. Hurst,** formerly chief chemist in the research and development branch of the Industrial Group at Risley, becomes director of the Dounreay Experimental Reactor Establishment ; **Mr. D. S. Mitchell,** formerly director of administration, becomes director of personnel and administration in the Industrial Group. All these appointments, which took effect on February 1st, mark a first stage towards implementing recommendations made by the committee appointed by the Prime Minister under the chairmanship of Sir Alexander Fleck, to examine the organisation of certain parts of the Authority. Further appointments will be announced in due course. **Mr. D. W. Fry,** chief physicist at Harwell, has been appointed a deputy director of the Atomic Energy Research Establishment and took up his new post on February 17th, 1958.

* * *

Mr. David H. Bramley, M.I.Mech.E., head of the department of industrial administration at the College of Technology, Birmingham, has joined the board of Geo. Salter & Co. Ltd., the West Bromwich spring and spring balance manufacturers. He will continue to hold his college appointment.

* * *

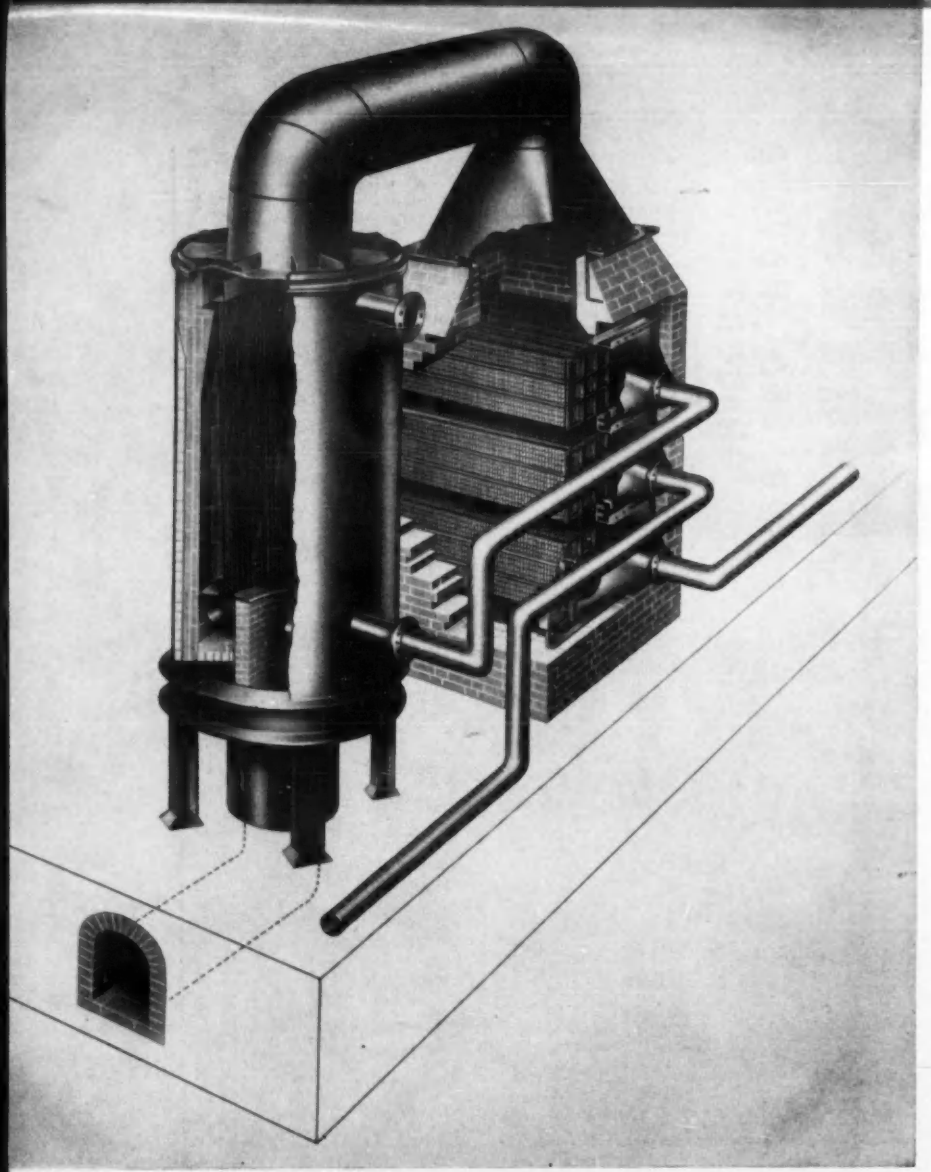
Rhodes, Brydon and Youatt, Ltd. has announced that **Mr. R. E. Breyer** has been appointed publicity manager.

* * *

The Harland Engineering Co. Ltd., has received an order amounting to over £100,000 for motor-driven boiler feed pumps for the Kincardine power station of the South of Scotland Electricity Board. The order covers six pump sets serving two 220-MW turbo-alternators. These pumps, which will be driven by 1,650 h.p. high-speed motors, will be the largest of their type to be installed in Scotland.

* * *

Dewrance Charity Box 1957 :— Visitors who have lunched with the executives at the Great Dover Street Works of Dewrance & Co. Ltd., during the past year are advised that the contents of the charity box on December 31st amounted to £114 16s. 0d. This money has been distributed to various local charities. The winners of the two prizes for the nearest guesses of the contents were Mr. K. C. Banks, of the Engineering and Allied Employers London & District Association, and Mr. A. S. Peacock, of Babcock & Wilcox Ltd.



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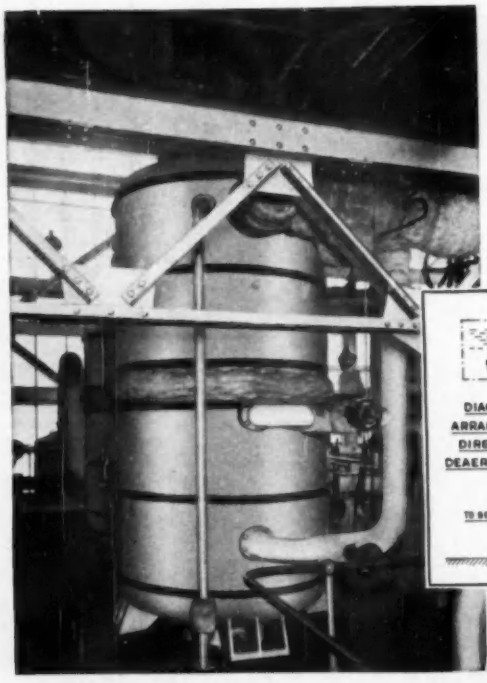

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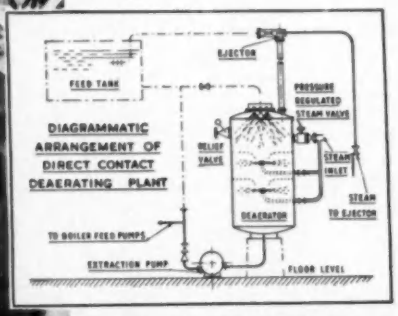

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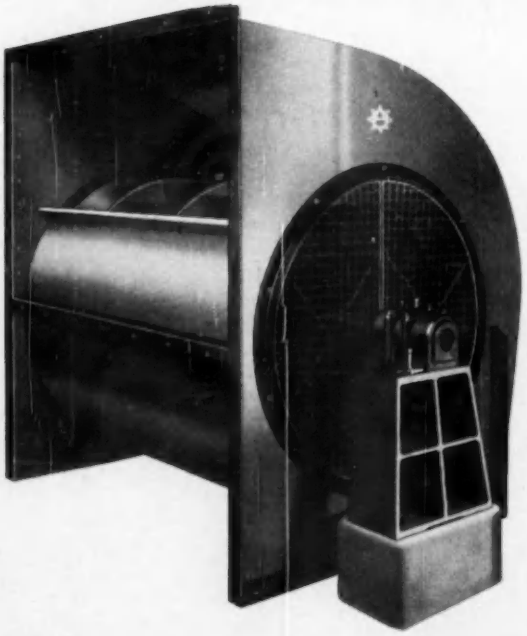

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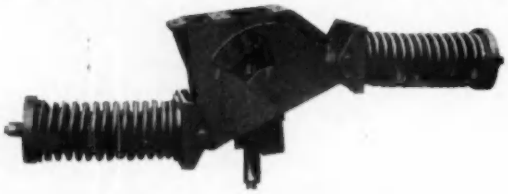

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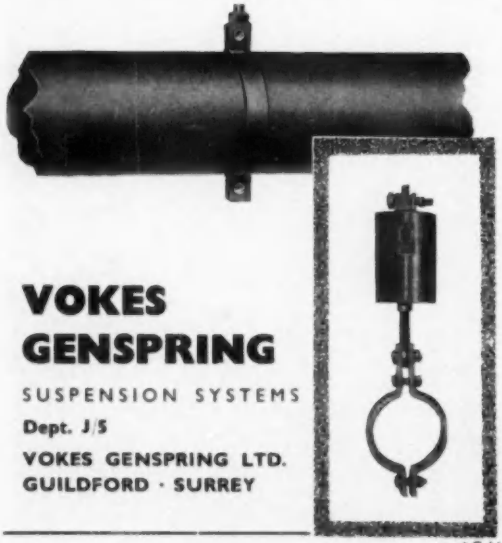

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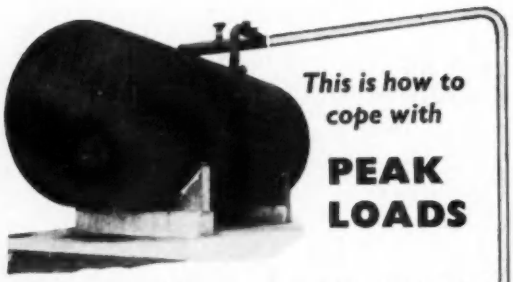

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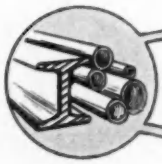

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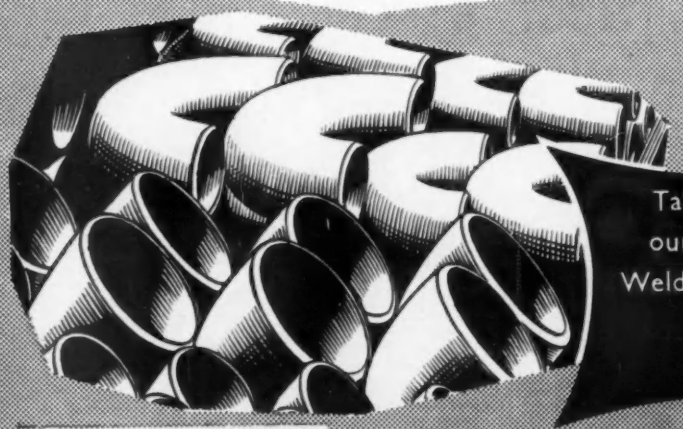

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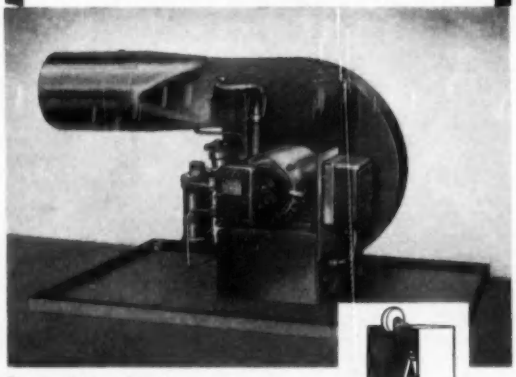

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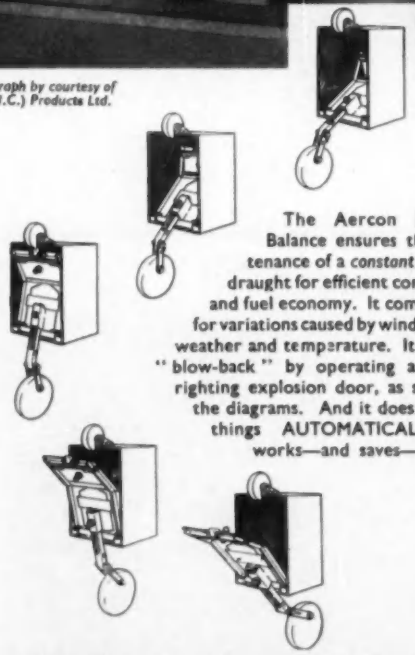

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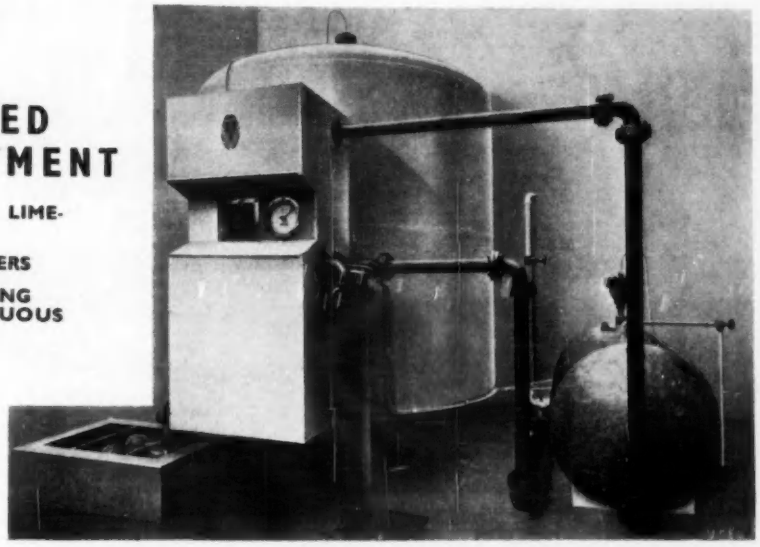

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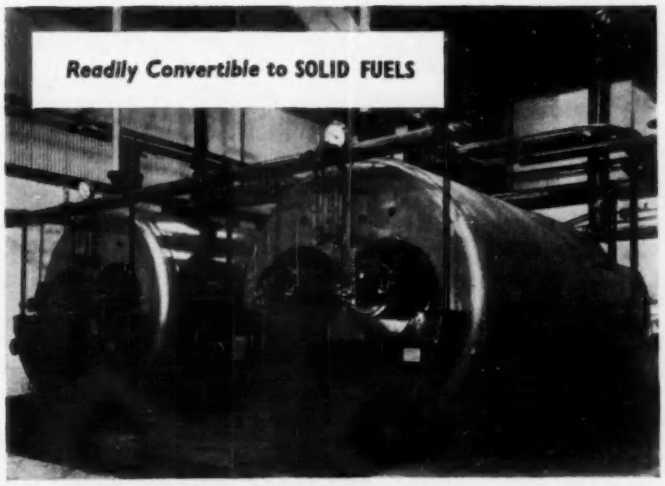

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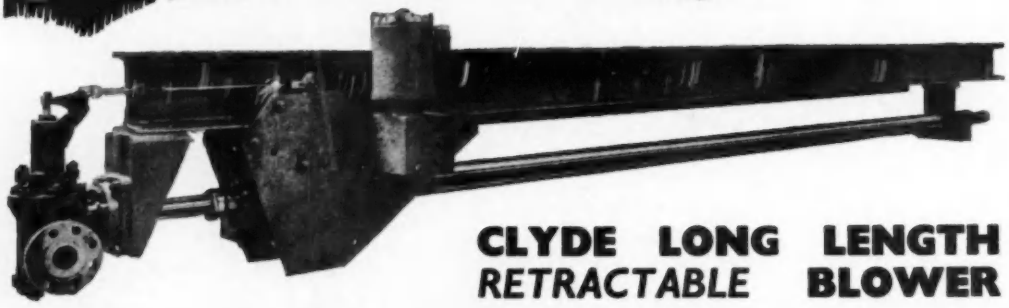

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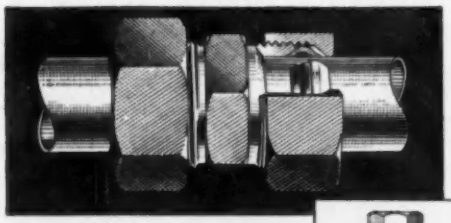

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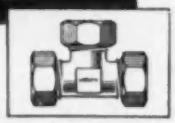

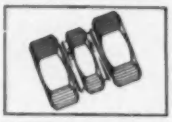

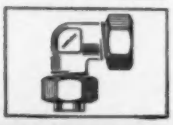

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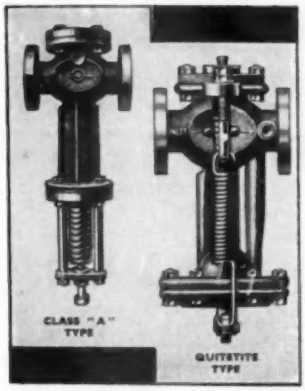

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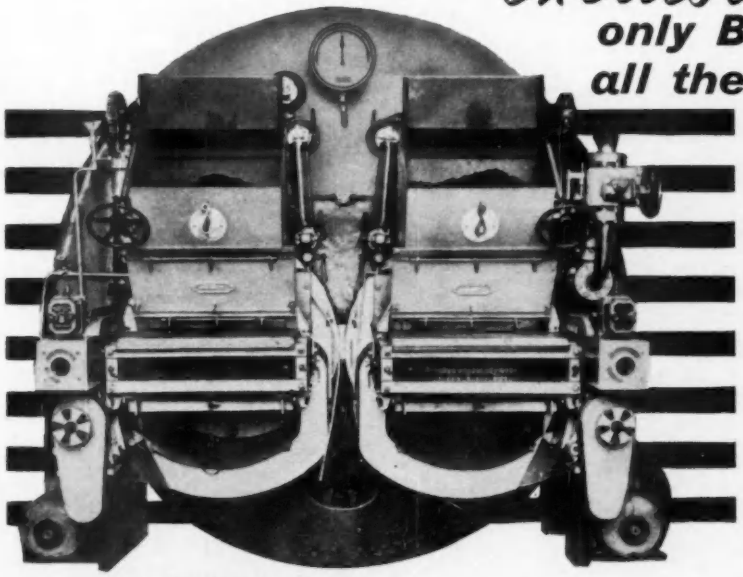

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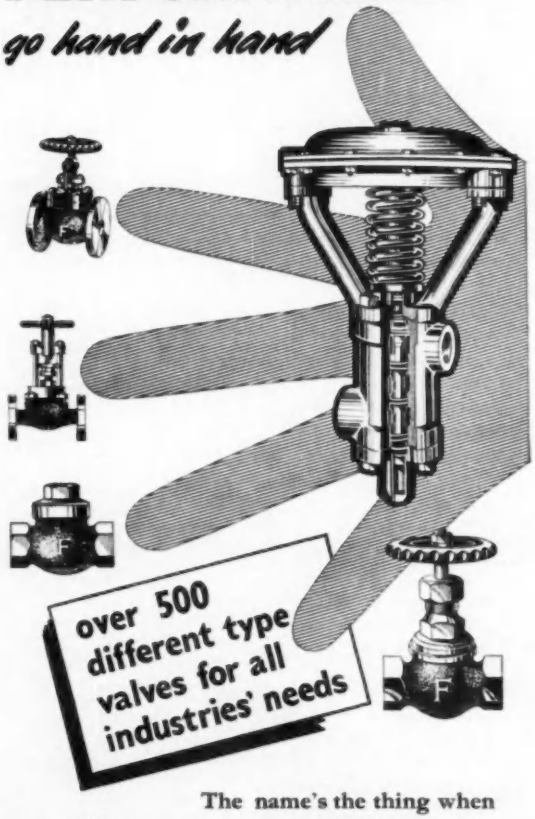

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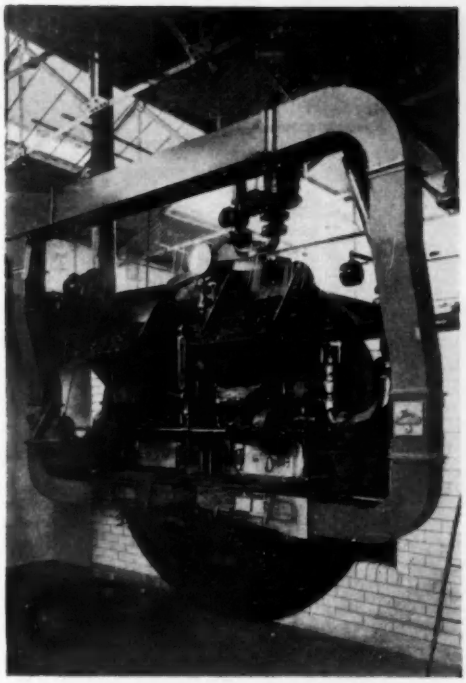

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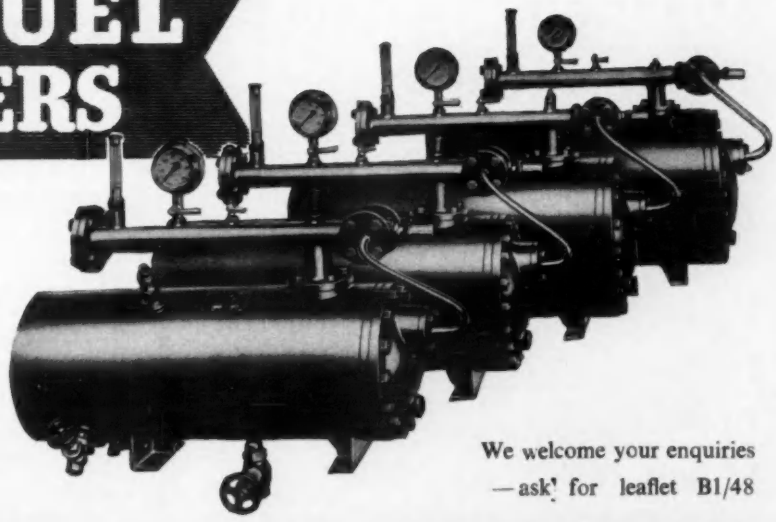

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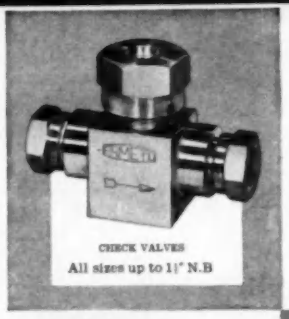

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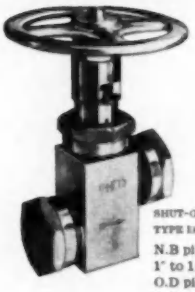

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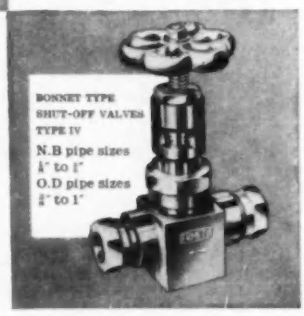

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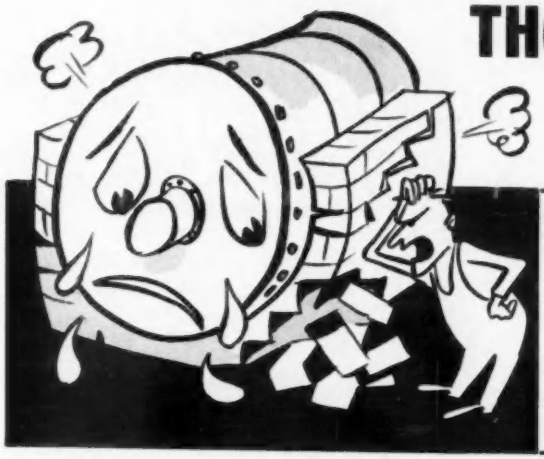

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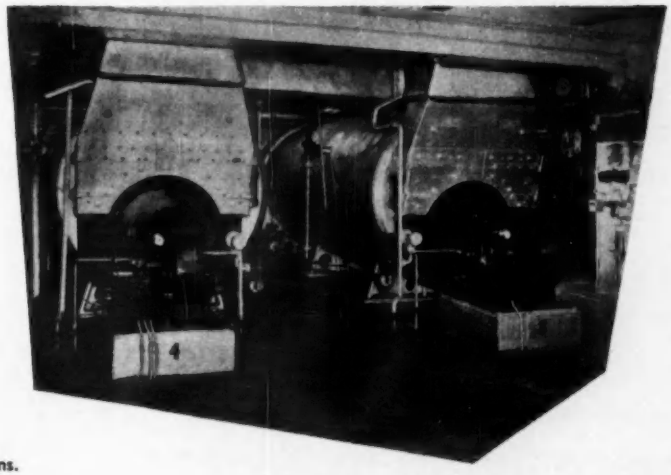

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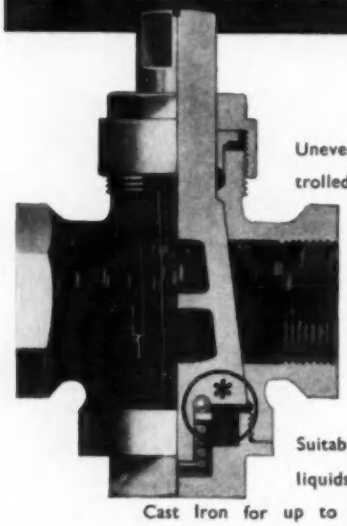

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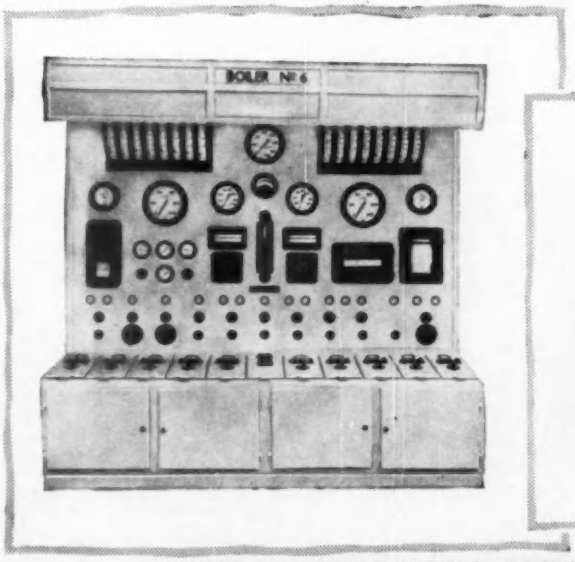

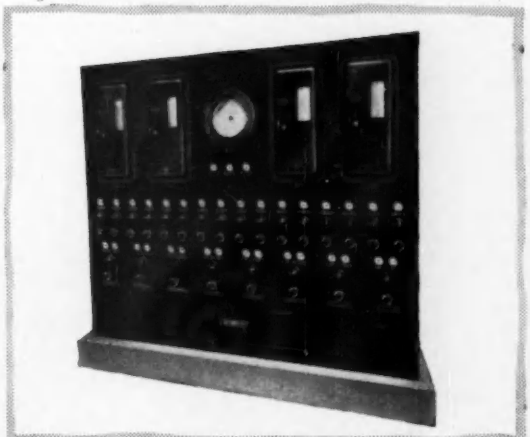

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